mercruiser

SERVICE MANUAL

Number 13

MARINE ENGINES

GM 4 Cylinder

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Notice

Throughout this publication, “Dangers,” “Warnings” and “Cautions” are used to alert the mechanic to special instructions concerning a particular service or operation that may be hazardous if performed incorrectly or carelessly. Observe them carefully!

These “Safety Alerts” alone cannot eliminate the hazards that they signal. Strict compliance to these special instructions when performing the service, plus “common sense” operation, are major accident prevention measures.

⚠ DANGER

DANGER - Immediate hazards which will result in severe personal injury or death.

⚠ WARNING

WARNING - Hazards or unsafe practices which could result in severe personal injury or death.

⚠ CAUTION

CAUTION - Hazards or unsafe practices which could result in minor personal injury or product or property damage.

Notice to Users of This Manual

This service manual has been written and published by the service department of Mercury Marine to aid our dealers, mechanics and company service personnel when servicing the products described herein.

It is assumed that these personnel are familiar with the servicing procedures of these products, of like or similar products manufactured and marketed by Mercury Marine, and that they have been trained in the recommended servicing procedures for these products which include the use of mechanic’s common hand tools and the special Mercury Marine or recommended tools from other suppliers.

We could not possibly know of and advise the service trade of all conceivable procedures by which a service might be performed and of the possible hazards and/or results of each method. We have not undertaken any such wide evaluation. Therefore, anyone who uses a service procedure and/or tool, which is not recommended by the manufacturer, first must completely satisfy himself that neither his nor the product’s safety will be endangered by the service procedure selected.

All information, illustrations and specifications contained in this manual are based on the latest product information available at time of publication.

It should be kept in mind, while working on the product, that the electrical system and ignition system are capable of violent and damaging short circuits or severe electrical shocks. When performing any work where electrical terminals could possibly be grounded or touched by the mechanic, the battery cables should be disconnected at the battery.

Any time the intake or exhaust openings are exposed during service they should be covered to protect against accidental entrance of foreign material which could enter the cylinders and cause extensive internal damage when the engine is started.

It is important to note that, during any maintenance procedure, replacement fasteners must have the same measurements and strength as those removed, whether metric or customary. Numbers on the heads of the metric bolts and on surfaces of metric nuts indicate their strength. Customary bolts use radial lines for this purpose, while most customary nuts do not have strength markings. Mismatched or incorrect fasteners can result in damage or malfunction, or possible personal injury. Therefore, fasteners removed should be saved for re-use in the same locations whenever possible. Where the fasteners are not satisfactory for re-use, care should be taken to select a replacement that meets the same specifications as the original.

Engine Mechanical Components

Many of the engine mechanical components are designed for marine applications. Unlike automotive engines, marine engines are subjected to extended periods of heavy load and wide-open-throttle operation and, therefore, require heavy-duty components. Special marine engine parts have design and manufacturing specifications which are required to provide long life and dependable performance. Marine engine parts also must be able to resist the corrosive action of salt or brackish water that will rust or corrode standard automotive parts within a short period of time.

Failure to use recommended Quicksilver service replacement parts can result in poor engine performance and/or durability, rapid corrosion of parts subjected to salt water and possibly complete failure of the engine.

Use of parts other than recommended service replacement parts, will void the warranty on those parts which are damaged as a result of the use of other than recommended replacement parts.

Replacement Parts

⚠ WARNING

Electrical, ignition and fuel system components on MerCruiser Engines and Stern Drives are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire or explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply to these rules and regulations, could result in a fire or explosion hazard and should be avoided.

When servicing the electrical, ignition and fuel systems, it is extremely important that all components are properly installed and tightened. If not, any electrical or ignition component opening would permit sparks to ignite fuel vapors from fuel system leaks, if they existed.

Models Covered In This Manual

MODEL	SERIAL NUMBER
MCM 3.0L	OC856451 And Above
MCM 3.0L /3.0LX	OC868143 And Above

IMPORTANT: Refer To ”Engine Identification”, Page 3A-7

NOTICE
Refer To Appropriate Stern Drive Manual fof transom assembly and stern drive unit repair.

Service Manual Outline

SECTION 1 - Important Information

A - General Information

B - Maintenance

C - Troubleshooting

SECTION 2 - Removal and Installation

A - 4 Cylinder 3.0L / 3.0 LX (181 C.I.D.)

SECTION 3 - Engine

A - G.M. In-Line

SECTION 4 - Electrical Systems

A - Starting System

B - Ignition System

C - Charging System

D - Instrumentation

E - Wiring Diagrams

SECTION 5 - Fuel System

A -Fuel Pump

B - MerCarb 2-Barrel

SECTION 6 - Cooling and Exhaust

A - Seawater Cooled Models

B - Closed Cooled Models

C - Exhaust Manifolds / Elbows

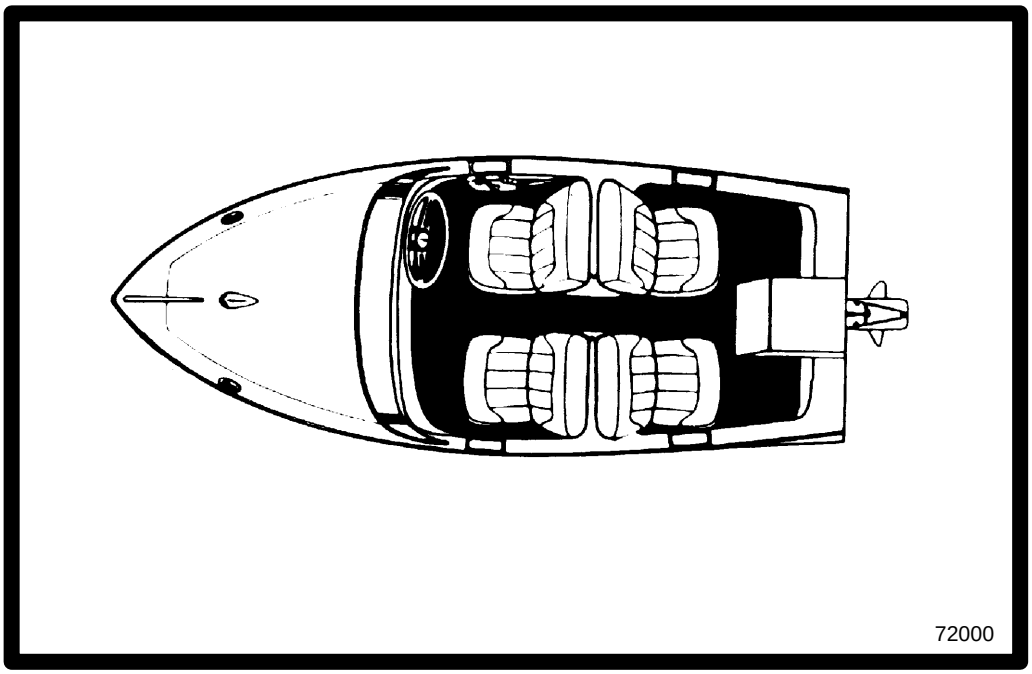
SECTION 7 - Power Steering

A - Power Steering

IMPORTANT INFORMATION

1

A



GENERAL INFORMATION

Index

Table of Contents

	Page
Introduction	1A - 1
How To Use This Manual	1A - 1
Page Numbering	1A - 1
How To Read Parts Manual	1A - 2
Directional References	1A - 3
Engine Rotation	1A - 3
Engine Serial Number Locations	1A - 3
Engine Identification	1A - 3
Propeller Information	1A - 3
Water Testing New Engines	1A - 4
Boat And Engine Performance	1A - 4
Boat Bottom	1A - 4
Marine Fouling	1A - 5
Weight Distribution	1A - 6
Water In Boat	1A - 6
Elevation And Climate	1A - 6

NOTICE

For information and procedures on trouble-shooting, refer to SECTION 1C.

NOTICE

Refer to appropriate Stern Drive Service Manual for transom assembly and stern drive unit repair.

Index

Introduction

This comprehensive overhaul and repair manual is designed as a service guide for the models previously listed. It provides specific information, including procedures for disassembly, inspection, assembly and adjustment to enable dealers and service mechanics to repair and tune these engines.

Before attempting repairs or tune-up, it is suggested that the procedure first be read through to gain knowledge of the methods and tools used and the cautions and warnings required for safety.

How to Use This Manual

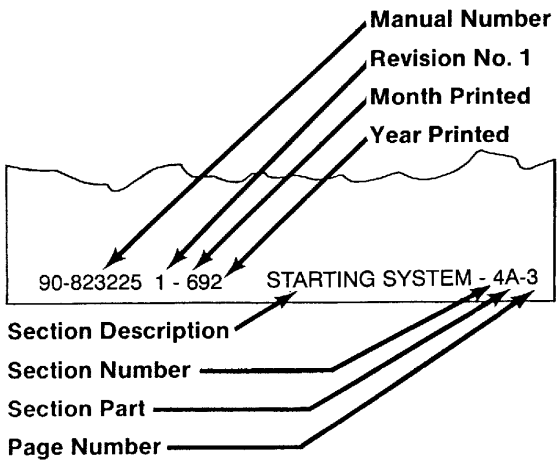
This manual is divided into sections which represent major components and systems.

Some sections are further divided into parts which more fully describe the component.

Sections and section parts are listed on the “Service Manual Outline” page following “V-8 Models Covered in This Manual” page.

Page Numbering

Two number groups appear at the bottom of each page. Following is an example and description.



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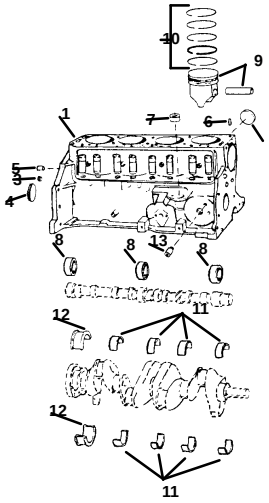
Index

How To Read Parts Manual



CYLINDER BLOCK AND CAMSHAFT

PART NO.	REF. NO.	DESCRIPTION	QUAN.
● 841-824146	1	CYLINDER BLOCK (See Note)	1
19-34270	2	EXPANSION PLUG	8
17-35465	3	DOWEL PIN	4
22-72640	4	EXPANSION PLUG	2
23-85674	5	BEARING UNIT (SET)	1
22-48556	6	BUSHING	2
22-32802	7	PIPE PLUG	1
22-42796	8	BY-PASS VALVE	1
19-816565	9	PLUG	1
811844	10	LIFTER	12
● 824331	11	RETAINER	2
● 10-824332	12	SCREW	4
● 824148	13	BALANCED SHAFT	1
● 31-824150	14	BEARING (REAR)	1

NOTE: 841-824146 Cylinder Block includes only standard pistons, piston rings, crankshaft bearings and camshaft bearings.

A. **Part Number:** For part ordering - Note N.S.S. for Reference Numbers, (not shown above) - means Not Sold Separately by Mercury Marine, however, in some cases, the G.M. Part Number (for the item) is given in the Description Column.

B. **Reference Number:** For part Shown on exploded parts view.

C. **Description:** This is the most important column because it gives:

1) Description of Part: Ref. No. 1 is a Cylinder Block Assembly, No. 13 is the Balanced Shaft, etc.

2) What parts are included with a certain part: Notice how the Description of Part, for Ref. Nos. 1, and 10 through 13, are at the left side of the column. Description of Part for Ref. Nos. 2 thru 9 are indented under "Cylinder Block". If Ref. No. 1 (Cylinder Block) was ordered, all indented parts (Ref. Nos. 2 thru 9) would come with the part. Ref. Nos. 10 thru 14 would not come with Ref. No. 1 and would have to be ordered separately. If 2 Cylinder Blocks were listed, both cylinder blocks would come with the indented parts. In some cases, an indented part will have another part indented under it. The second indented part will come with the first indented part.

3) Serial number break: If serial number information is listed, check product serial number to ensure that correct part is ordered.

4) Special information: Many times special information will be shown after description such as; L.H. Rotation, R. H. Rotation, Filter up, Filter Down, etc. This will help in selecting the correct part.

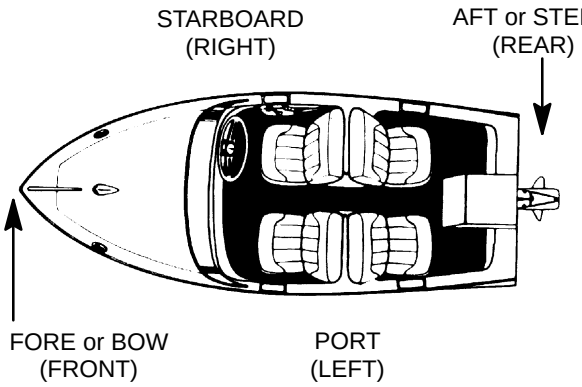
D. **Quantity:** Quantity that has to be ordered.

E. **Special Information Block:** Additional information, part numbers for gasket sets, etc.

Index

Directional References

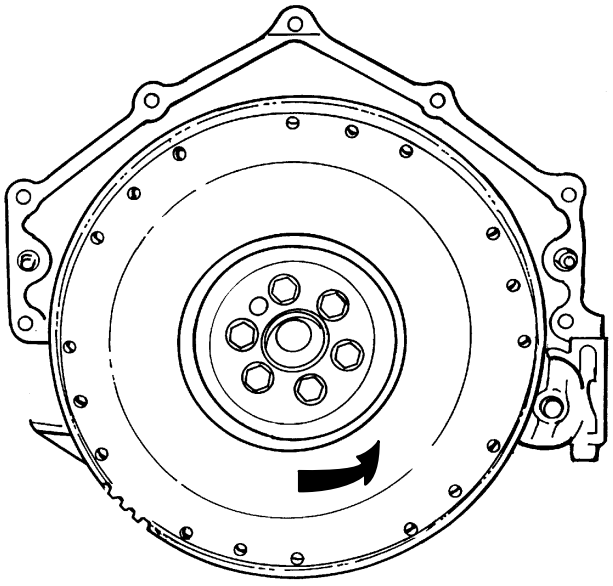
Front of boat is bow; rear is stern. Starboard side is right side; port side is left side. In this maintenance manual, all directional references are given as they appear when viewing boat from stern looking toward bow.



72000

Engine Rotation

Engine rotation is determined by observing flywheel rotation from the rear (stern end) of the engine looking forward (toward water pump end). Propeller rotation is not necessarily the same as engine rotation. When ordering replacement engine, short blocks or parts for engine, be certain to check engine rotation. Do not rely on propeller rotation in determining engine rotation.



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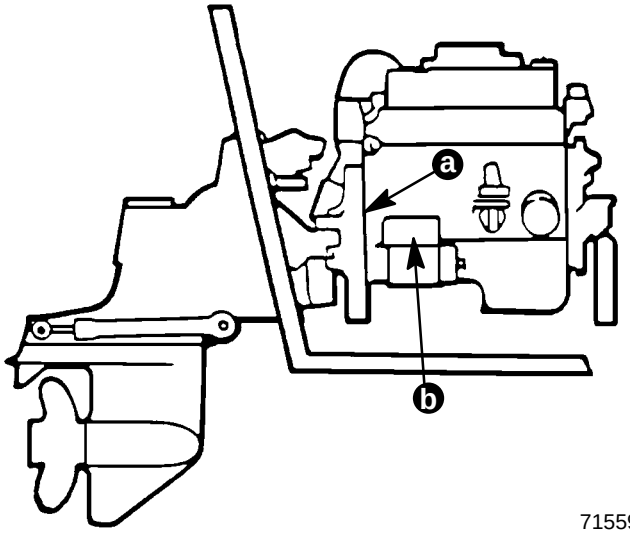
Standard Left-Hand Rotation

Engine Serial Number Locations



71559

a - Serial Number Plate
b - Starter Motor

Engine Identification

Refer to SECTION 3A for engine block identification.

Propeller Information

Refer to the “Propeller” section in appropriate MerCruiser Stern Drive Service Manual, or order publication 90-86144, “What You Should Know About Quicksilver Propellers.”

Changing diameter, pitch or coupling of a propeller will affect engine RPM and boat performance . The blade configuration also will affect performance. Two like propellers, same pitch and diameter, from two different manufacturers also will perform differently.

It is the responsibility of the boat manufacturer and/or selling dealer to equip the boat with the correct propeller to allow the engine to operate within its specified RPM range at wide-open-throttle (W.O.T.).

Because of the many variables of boat design and operation, only testing will determine the best propeller for the particular application.

To test for correct propeller, operate boat (with an average load onboard) at W.O.T. and check RPM with an accurate tachometer. Engine RPM should be near top of the specified range so that, under heavy load, engine speed will not fall below specifications.

Index

If engine exceeds the specified RPM, an increase in pitch and/or diameter is required.

If engine is below rated RPM, a decrease in pitch and/or diameter is required.

Normally, a change of approximately 300 to 500 RPM will be achieved for each single pitch change of a propeller.

⚠CAUTION

If a propeller is installed that does not allow engine RPM to reach the specified full-throttle RPM range, the engine will "labor" and will not produce full power. Operation under this condition will cause excessive fuel consumption, engine overheating and possible piston damage (due to detonation). On the other hand, installation of a propeller, that allows engine to run above the specified RPM limit, will cause excessive wear on internal engine parts which will lead to premature engine failure.

Water Testing New Engines

Use care during the first 20 hours of operation on new MerCruiser engines or possible engine failure may occur. If a new engine has to be water-tested at full throttle before the break-in period is complete, follow this procedure.

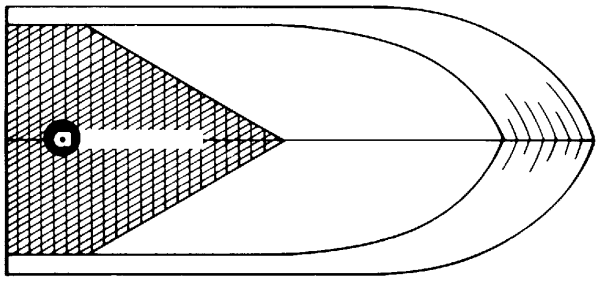
1. Run boat up on plane.
2. Advance engine RPM (in 200 RPM increments) until engine reaches its maximum rated RPM.

IMPORTANT: Do not run at maximum RPM for more than 2 minutes.

Boat and Engine Performance

Boat Bottom

For maximum speed, a boat bottom should be as flat as possible in a fore-aft direction (longitudinally) for approximately the last 5 ft. (1.5 m).



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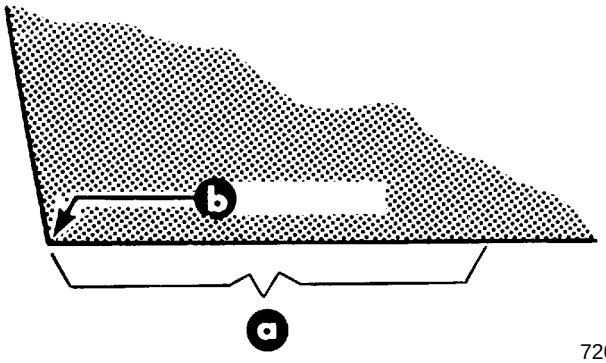
a - Critical Bottom Area

For best speed and minimum spray, the corner between the bottom and the transom should be sharp.

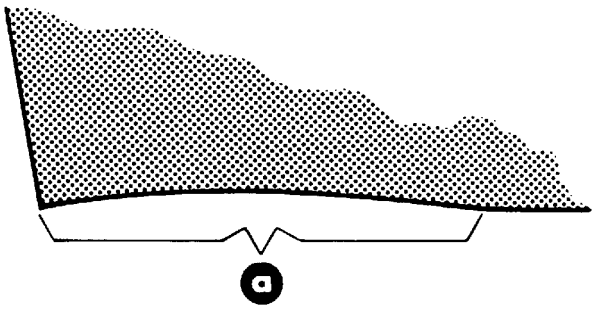


72003

a - Flat
b - Sharp Corner

Index

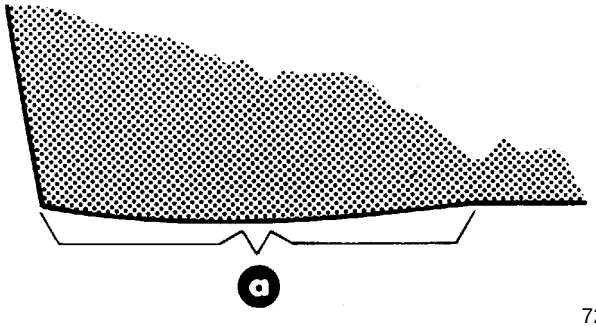
The bottom is referred to as having a “hook” if it is concave in the fore-and-aft direction. A hook causes more lift on the bottom near the transom and forces the bow to drop. This increases wetted surface and reduces boat speed. A hook, however, aids in planing and reduces any porpoising (rhythmical bouncing) tendency. A slight hook is often built in by the manufacturer. A hook also can be caused by incorrect trailering or storing the boat with support directly under the transom.



72004

a - Hook

A “rocker” is the reverse of a hook. The bottom is convex or bulged in the fore-and-aft direction. It can cause the boat to porpoise.



72005

a - Rocker

Any hook, rocker or surface roughness on the bottom, particularly in the all-important center-aft portion will have a negative effect on speed, often several miles per hour on a fast boat.

Marine Fouling

Fouling is an unwanted build-up (usually animal-vegetable-derived) occurring on the boat’s bottom and drive unit. Fouling adds up to drag, which reduces boat performance. In fresh water, fouling results from dirt, vegetable matter, algae or slime, chemicals, minerals and other pollutants. In salt water, barnacles, moss and other marine growth often produce dramatic build-up of material quickly. Therefore, it is important to keep the hull as clean as possible in all water conditions to maximize boat performance.

Antifouling paint, if required, may be applied to boat hull observing the following precautions.

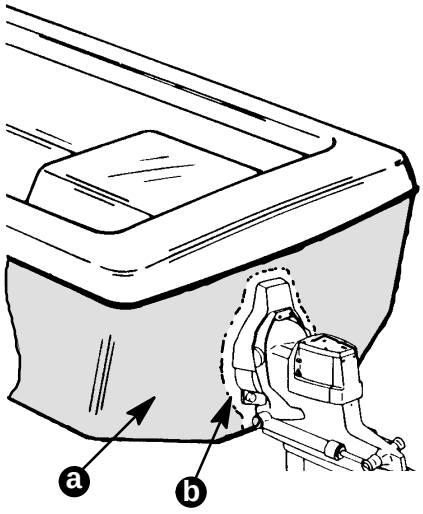
IMPORTANT: DO NOT paint anodes or MerCathode System reference electrode and anode, as this will render them ineffective as galvanic corrosion inhibitors.

⚠CAUTION

Avoid corrosion damage. Do not apply antifouling paint to MerCruiser drive unit or transom assembly.

IMPORTANT: If antifouling protection is required, Tri-Butyl-Tin-Adipate (TBTA) base antifouling paints are recommended on MerCruiser boating applications. In areas where Tri-Butyl-Tin-Adipate base paints are prohibited by law, copper base paints can be used on boat hull and boat transom. Corrosion damage that results from the improper application of antifouling paint will not be covered by the limited warranty. Observe the following:

Avoid an electrical interconnection between the MerCruiser Product, Anodic Blocks, or MerCathode System and the paint by allowing a minimum of 1 in. (26mm) UNPAINTED area on transom of the boat around these items.



71176

a - Antifouling Paint
b - MINIMUM 1 inch (26 mm) UNPAINTED Area

Index

Weight Distribution

Weight distribution is extremely important; it affects a boat's running angle or attitude. For best top speed, all movable weight - cargo and passengers - should be as far aft as possible to allow the bow to come up to a more efficient angle (3 to 5 degrees). On the negative side of this approach is the problem that, as weight is moved aft, some boats will begin an unacceptable porpoise.

Secondly, as weight is moved aft, getting on plane becomes more difficult.

Finally, the ride in choppy water becomes more uncomfortable as the weight goes aft. With these factors in mind, each boater should seek out what weight locations best suit his/her needs.

Weight and passenger loading placed well forward increases the "wetted area" of the boat bottom and, in some cases, virtually destroys the good performance and handling characteristics of the boat. Operation in this configuration can produce an extremely wet ride, from wind-blown spray, and could even be unsafe in certain weather conditions or where bow steering may occur.

Weight distribution is not confined strictly to fore and aft locations, but also applies to lateral weight distribution. Uneven weight concentration to port or starboard of the longitudinal centerline can produce a severe listing attitude that can adversely affect the boat's performance, handling ability and riding comfort. In extreme rough water conditions, the safety of the boat and passengers may be in jeopardy.

Water in Boat

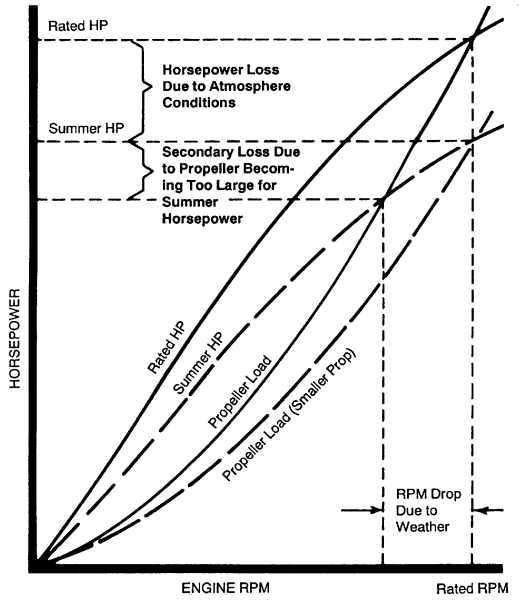
When a boat loses performance, check bilge for water. Water can add considerable weight to the boat, thereby decreasing the performance and handling.

Make certain that all drain passages are open for complete draining.

Elevation and Climate

Elevation has a very noticeable effect on the wide-open-throttle power of an engine. Since air (containing oxygen) gets thinner as elevation increases, the engine begins to starve for air. Humidity, barometric pressure and temperature do have a noticeable effect on the density of air. Heat and humidity thin the air. This phenomenon can become particularly annoying when an engine is propped out on a cool dry day in spring and later, on a hot, sultry day in August, does not have it's normal performance. (See chart.)

Although some performance can be regained by dropping to a lower pitch propeller, the basic problem still exists. The propeller is too large in diameter for the reduced power output. The experienced marine dealer or a Quicksilver Propeller Repair Station can determine how much diameter to remove from a lower-pitch propeller for specific high-elevation locations. In some cases, a gear-ratio change to the drive unit to more reduction is possible and very beneficial. It is a known fact that weather conditions exert a profound effect on power output of internal combustion engines. Therefore, established horsepower ratings refer to the power that the engine will produce at its rated RPM under a specific combination of weather conditions.



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Index

IMPORTANT INFORMATION

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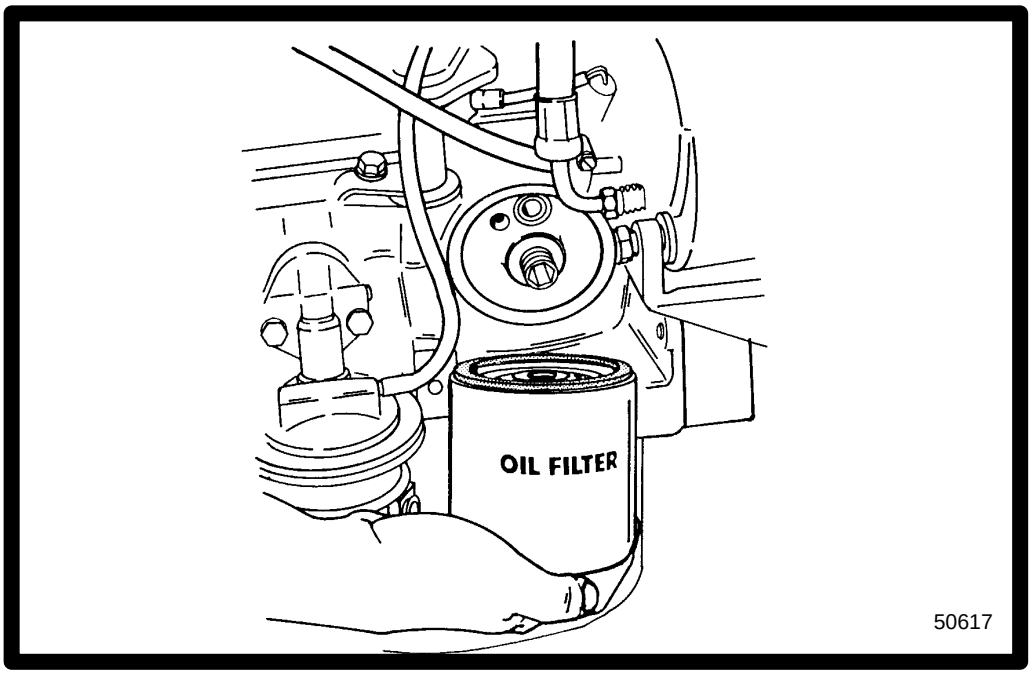


MAINTENANCE

Index

Table of Contents

	Page
Maintenance Schedule	1B - 1
To Be Done by Owner	1B - 1
Maintenance Schedule (Continued)	1B - 2
To Be Done by Dealer	1B - 2
Tune-Up Specifications	1B - 3
Fluid Capacities	1B - 4
4 Cylinder	1B - 5
20-Hour Break-In Period	1B - 5
After 20 Hour Break-In Period	1B - 5
20-Hour Checkup	1B - 5
Fuel, Oil, Fluid, and Coolant Specifications	1B - 6
Fuel	1B - 6
Gasoline/Alcohol Blends	1B - 7
Effects of Gasoline/Alcohol Blends on Marine Engines	1B - 7
Boat/Motor Storage	1B - 7
Winter Storage	1B - 7
Warranty	1B - 7
Continuing Evaluations	1B - 7
Test For Alcohol Content In Gasoline	1B - 7
Crankcase Oil	1B - 8
Priming Engines with Oil	1B - 8
Power Steering Fluid	1B - 8
Coolant for Closed Cooling System	1B - 9
Maintaining Crankcase Oil Level	1B - 9
Overfilled Engine Crankcase	1B - 9
Checking Engine Oil Level/Filling	1B - 9
Changing Oil and Filter	1B - 9
Maintaining Power Steering Pump Fluid Level	1B - 10
With Engine Warm	1B - 10
With Engine Cold	1B - 10
Filling and Bleeding Power Steering System	1B - 11
Maintaining Closed Cooling Coolant Level	1B - 11
Flushing Cooling System	1B - 11
Lubrication	1B - 13
Throttle Cable	1B - 13
Models with 2 Barrel Carburetor	1B - 13
Shift Cable	1B - 13
Engine Coupler/U-Joint Shaft Splines	1B - 14
Audio Warning System	1B - 14
Maintenance	1B - 14
Cold Weather or Extended Storage	1B - 14
Precautions	1B - 14
Layup	1B - 15
Draining Instructions	1B - 16
Draining Seawater (Raw-Water) Cooled Models	1B - 16
Draining Seawater Section of Closed Cooled (Coolant) Models	1B - 18
Recommissioning	1B - 19

NOTICE

For information and procedures on troubleshooting, refer to SECTION 1C.

Maintenance Schedule

Always disconnect battery cables from battery BEFORE working around electrical system components to prevent injury to yourself and damage to electrical system should a wire be accidentally shorted.

To Be Done by Owner

TASK	INTERVAL
Cooling System - Flush seawater section	**Saltwater:** After each use
Seawater strainer	Clean as required
Power package exterior surfaces - clean and paint	Once a year
Engine crankcase oil - check level	Weekly
Closed cooling coolant - check level	
Power steering fluid - check level	
Stern drive unit oil - check level	
Battery check level and inspect for damage	
Fuel pump sight tube - check that no fuel is present	
Power trim pump oil - check level	
Anodes - inspect for erosion	
Drive belts (all) - inspect condition and check tension	Every 100 hours or 120 days, whichever occurs first
Propeller shaft - lubricate	**Saltwater:** Every 50 hours or 60 days, whichever occurs first. **Freshwater:** Every 100 hours or 120 days, whichever occurs first.
Power package exterior surfaces - spray with rust preventive	
Power package exterior surfaces - clean and paint	Once a year
Cooling system - flush seawater section	**Saltwater:** after each use

Maintenance Schedule (Continued)

To Be Done by Dealer

TASK	INTERVAL
20–Hour checkup (NOTE 1)	20 hours
Seawater pickup pump - disassemble and inspect	Whenever insufficient seawater flow is suspected. (if operating temperature exceeds normal range)
Flame arrestor and crankcase ventilation hose - clean and inspect	Every 100 hours or once yearly, whichever occurs first
Stern drive unit oil - change	
Gimbal ring clamping screws - retorque to 40 lb. ft. (54 N·m)	
Engine alignment - check	
Transom gimbal housing assembly swivel shaft and gimbal bearing - lubricate	
Engine coupling, universal joint shaft splines - lubricate (see NOTE 2)	
Crankcase oil and filter - change	
Ignition system - clean and inspect condition	
Universal joint cross bearings - lubricate	Every 200 hours or once yearly, whichever occurs first.
Steering system - lubricate and inspect for loose, damaged or missing parts.	**Saltwater:** Every 50 hours or 60 days, whichever occurs first. **Freshwater:** Every 100 or once yearly, whichever occurs first.
Electrical system - check for loose or damaged wiring.	
Continuity circuit - check components for loose connections,broken or frayed wires.	
Shift, throttle cables and linkages - lubricate and inspect for loose, damaged or missing parts.	
Cooling system hoses and clamps - inspect for damage and deterioration. Check hose clamps for tightness.	
Engine exhaust system - inspect for damage, deterioration and restrictions. Check hose clamps for tightness.	
Ignition system - check timing and adjust if needed.	Once a year
Fuel filters - replace	
Steering head and remote control - inspect and lubricate.	
Quicksilver Mercathode system - test output	
Closed cooling coolant - test for alkalinity.	
Heat exchanger - Clean seawater section	
Carburetor - inspect and adjust	
Drive unit bellows and clamps - inspect	
Closed cooling coolant - replace	Every two years

NOTE 1: For a list of 20 Hour Check up maintenance items to be performed, see ”Important Information’ section of this manual.

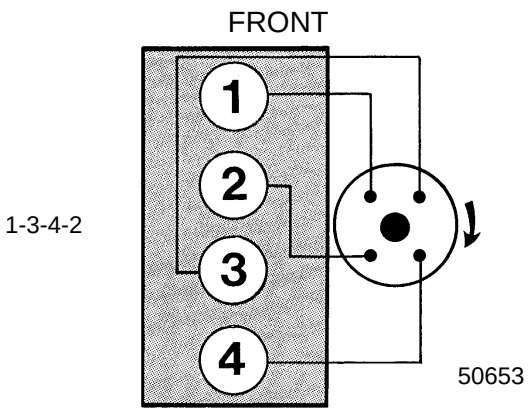
NOTE 2: Refer to ”Lubrication” later in this section for engine coupler lubrication and/or related information

Tune-Up Specifications

Model		MCM 3.0L	MCM 3.0LX
Propshaft Horsepower Ratings (Kilowatts)		115 (86)	135 (101)
Number Of Cylinders		4	
Displacement		181 CID (3.0L)	
Bore/Stroke		4.00 in./3.60 in. (101.6/91.4 mm)	
Compression Ratio		9.25:1	
Compression Pressure		140 PSI (966 kPa)	
Idle RPM (in Forward Gear)		650-700	
Maximum RPM (at W.O.T.)		4200-4600	4400-4800
OIl Pressure (at 2000 RPM)		30-60 PSI (207-414 kPa)	
Min. Oil Pressure (at Idle)		5 - 6-1/2 PSI (35-44 kPa)	
Fuel (Pump) Pressure		12 Volt Negative (–) Ground	
Min. Battery Cold Cranking Amperes		375 cca / 475 mca / 90 Ah	
Firing Order		1-3-4-2	
Spark Plug Type		AC-MR43T Champion RV15YC4 NGK BR6FS	AC-MR43LTS Champion RS9YC NGK BPR6EFS
Spark Plug Gap		.035 In. (0.9 mm)	
Timing (at Idle RPM)	Breaker Points Ignition	8° BTDC	
	DDIS Ignition	8° BTDC	
	Delco EST Ignition	1° BTDC (NOTE)	
Preliminary Idle Mixture		1 -1/4 Turns	
Thermostat		143°F (62° C)	
Dwell		39° - 45°	
Breaker Point Gap		.016 in. (0.5 mm)	
Breaker Point Spring Tension		20-27 oz. (567 - 765 g)	

NOTE: *Timing must be set using a special procedure as outlined in the appropriate Service Manual. Timing cannot be properly set using the conventional method.*

L.H. ROTATION FIRING ORDER



Engine Firing Order

Fluid Capacities

NOTICE
All capacities are approximate fluid measures.

MCM (Stern Drive) Model	All Models
Crankcase Oil[1] (with filter)	4 U.S. Qts. (3.8 L)
Seawater Cooling System[2]	9 U.S. Qts. (3.8 L)
Closed Cooling System	9 U.S. Qts. (8.5 L)

[1] Always use dipstick to determine exact quantity of oil required
[2] Seawater cooling system capacity information is for winterization use only

4 Cylinder

20-Hour Break-In Period

IMPORTANT: The first 20 hours of operation is the engine break-in period. Correct break-in is essential to obtain minimum oil consumption and maximum engine performance. During this break-in period, the following rules must be observed:

- Do not operate below 1500 RPM for extended periods of time for first 10 hours. Shift into gear as soon as possible after starting and advance throttle above 1500 RPM if conditions permit safe operation.
- Do not operate at one speed consistently for extended periods.
- Do not exceed 3/4 throttle during first 10 hours. During next 10 hours, occasional operation at full throttle is permissible (5 minutes at a time maximum).
- Avoid full throttle acceleration from idle speed.
- Do not operate at full throttle until engine reaches normal operating temperature.
- Frequently check crankcase oil level. Add oil if needed. It is normal for oil consumption to be high during break-in period.
- After 20-hour break-in period, drain crankcase oil and replace oil filter (see “Maintenance”). Fill crankcase with correct oil (see “Specifications”).

After 20 Hour Break-In Period

To help extend the life of your MerCruiser power package, the following recommendations should be considered:

- Use a propeller that allows the engine to operate at or near the top of the maximum RPM range (See Specifications) when at full throttle with a normal boat load.
- Operation at 3/4 throttle setting or lower is recommended. Refrain from prolonged operation at maximum (full throttle) RPM.

20-Hour Checkup

After first 20 hours of operation, an Authorized MerCruiser Dealer should be contacted for the following maintenance. The boat owner is responsible for any charges.

- Change crankcase oil and filter.
- Check all fluid levels.
- Cooling Systems - Inspect all hoses for damage and deterioration; check all hose clamps for adequate tightness.
- Check carburetor adjustment.
- Inspect ignition system and timing.
- Check for loose, missing or damaged parts.
- Check shift and throttle cable adjustments - Lubricate and inspect for loose, damaged or missing parts.
- Steering System - Lubricate and inspect for loose, damaged or missing parts.
- Inspect all drive belts.
- Check engine alignment.
- Complete Engine Exhaust System - Inspect externally for damage and deterioration; check all hose clamps for adequate tightness.
- Front engine mounts-Tighten securely and ensure that thejam nut is tight.
- Rear mounts-Check torque to 35-40 lb. ft. (47-54 N·m).
- Retorque gimbal ring clamping U-bolt to 55 lb. ft. (74 N·m).

Fuel, Oil, Fluid, and Coolant Specifications

Fuel

⚠CAUTION

Use of improper gasoline can damage the engine seriously. Engine damage that results from use of improper gasoline is considered misuse of the engine and is not covered under MerCruiser Warranty.

USA and Canada
Fuel having a posted pump Octane Rating of 87(R + M)/2 minimum. Premium gasoline [92 (R + M)/2] is also acceptable. DO NOT use leaded gasoline.

Outside USA and Canada
Fuel having a posted pump Octane Rating of 90 RON minimum. Premium gasoline (98 RON) is also acceptance. If unleaded is not available, use a major brand of leaded gasoline.

Using Reformulated (Oxygenated) Gasolines (USA Only)

This type of gasoline is required in certain areas of the USA. The two types of ”oxygenates” used in these fuels is Alcohol (Ethanol) or Ether (MTBE or ETBE). If Ethanol is the ”oxygenate” that is used in the gasoline in your area, refer to ”Gasoline Containing Alcohol” also.

These ”Reformulated Gasolines” are acceptable for use in your MerCruiser engine.

Gasolines Containing Alcohol

The fuel system components on your MerCruiser engine will withstand up to 10% content in the gasoline. We do not know what percentage your boat manufacturer for specific recommendations on the boats fuel system components (fuel tanks, fuel lines, and fittings).

Gasolines containing alcohol, either methyl alcohol (methanol) or ethyl alcohol (ethanol) may cause increased:

- Corrosion of metal parts.
- Deterioration of elastomer and plastic parts.
- Fuel permeation through flexible fuel lines.
- Wear and damage of internal engine parts.
- Starting and operating difficulties.

Some of these adverse effects are due to the tendency of gasolines containing alcohol to absorb moisture from the air, resulting in a phase of water and alcohol separating from the gasoline in the fuel tank.

The adverse effects of alcohol are more severe with methyl alcohol (methanol) and are worse with increasing alcohol content.

⚠WARNING

Fire and Explosion Hazard: Fuel leakage from any part of the fuel system can be a fire and explosion hazard which can cause serious bodily injury or death. Careful periodic inspection of the entire fuel system is mandatory, particularly after storage. All fuel system components including fuel tanks (whether plastic, metal or fiberglass), fuel lines, primer bulbs, fittings, fuel filters and carburetors should be inspected for leakage, softening, hardening, swelling or corrosion. Any sign of leakage or deterioration requires replacement before further engine operation.

Because of possible adverse effects of alcohol in gasoline, it is recommended that only alcohol-free gasoline be used where possible. If only fuel containing alcohol is available, or if the presence of alcohol is unknown, increased inspection frequency for leaks and abnormalities is required.

⚠WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak.

GASOLINE/ALCOHOL BLENDS

Many new motor vehicle owner manuals are warning about the potential damage from using gasoline containing alcohol, especially METHANOL. They cite possible fuel system damage and performance problems. These are just two of the hazards that may be caused by alcohol. These same problems as well as the additional safety risk of fire and explosion from fuel system leaks apply to marine inboard engines. METHANOL is more severe in its bad effect than is ETHANOL. Alcohol is also more severe in older engines since newer engines have materials which are more resistant to alcohol.

EFFECTS OF GASOLINE/ALCOHOL BLENDS ON MARINE ENGINES

Corrosion of metals may result from use of alcohol-gasoline blends. Portable or permanently installed fuel tanks of metal or fiberglass, fuel filters, fuel lines and float bowls may be affected by alcohol blended fuels. Many fiberglass fuel tanks are slowly dissolved by alcohol, leading immediately to filter and carburetor plugging and eventually to tank failure.

Fuels containing alcohol will absorb moisture from the air. At first, this moisture will remain in solution, but once the water content of the fuel has built up to about one-half of one percent, it will separate out (phase separation), bringing the alcohol with it. This alcohol-water mixture settles to the bottom of the fuel tank and if this mixture gets into the engine, the engine can be seriously damaged internally, as it may wash the protective film of oil off the bore of any cylinder that it enters. Before the engine can be restarted, it is necessary to remove the separated alcohol and water layer, flush out the fuel system with clean fuel and remove and dry the spark plugs.

BOAT/MOTOR STORAGE

When operating a MerCruiser engine on gasoline containing alcohol, storage of gasoline in the fuel tank for long periods of time should be avoided.

Long periods of storage, common to boats, create unique problems. In cars, gasoline/alcohol blend fuels normally are consumed before they can absorb enough moisture to cause trouble, but boats often sit idle long enough for phase separation to take place. In addition, internal corrosion may take place during storage if alcohol has washed protective oil films from internal components.

WINTER STORAGE

If boat is to be placed in winter storage, carburetors must be run dry at idle RPM. Permanent fuel tanks should be drained completely and Quicksilver Gasoline Stabilizer and Conditioner added to any fuel remaining in the tank. Portable fuel tanks should be emptied completely.

WARRANTY

Performance problems and fuel system or other damage resulting from the use of gasoline-alcohol blended fuels are not the responsibility of MerCruiser and will not be covered under our warranty.

CONTINUING EVALUATIONS

The effects of gasoline with ETHANOL and METHANOL are still being evaluated by the United States Coast Guard, the National Marine Manufacturers Association (NMMA), Mercury Marine and other engine and boat manufacturers.

We have recommended pump posting of alcohol content of gasoline. Further we recommend using gasoline known not to contain any METHANOL or ETHANOL when possible.

TEST FOR ALCOHOL CONTENT IN GASOLINE

The following is an acceptable and widely used field procedure for the detection of alcohol in gasoline. Use any small transparent bottle or tube that can be capped and is, or can be, provided with graduations or a mark at about 1/3 full. A pencil mark on a piece of adhesive tape may be used.

Procedure:

1. Fill the container with water to the mark.
2. Add fuel almost to fill the container, leaving some air space, then cap the container. The proportions of fuel to water are not critical, but there should be 2 to 3 times as much fuel as water.
3. Shake container vigorously and allow it to sit **upright for 3 to 5 minutes**. If the volume of water appears to have increased, alcohol is present. If you are not sure, there is no need for concern. If the dividing line between water and fuel becomes cloudy, use the middle of the cloudy band.

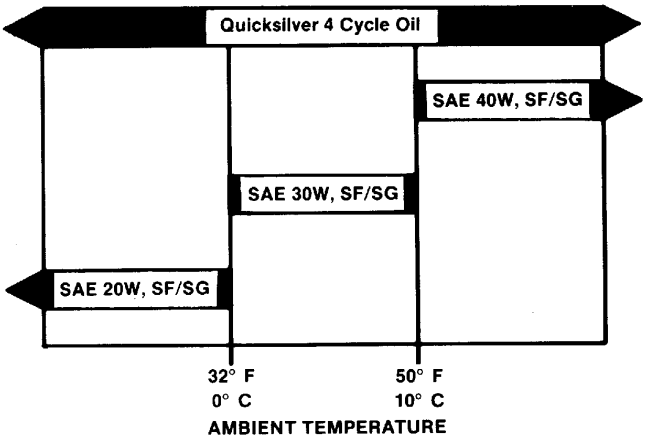
Crankcase Oil

To help obtain optimum engine performance and to provide maximum protection, we strongly recommend the use of Quicksilver 4-Cycle Marine Engine Oil. If not available, a good grade, straight weight, detergent automotive oil of correct viscosity, with an API classification of SF or SG, may be used.

The following chart is a guide to crankcase oil selection. Oil filter should always be changed with oil.

In those areas where recommended straight weight oil is not available, a multi-viscosity 20W-40 (SF or SG) or, as a second but less preferable choice, 20W-50 (SF or SG) may be used.

IMPORTANT: The use of non-detergent oils, multi-viscosity oils (other than 20W-40 or 20W-50), low quality oils or oils which contain solid additives specifically are not recommended.



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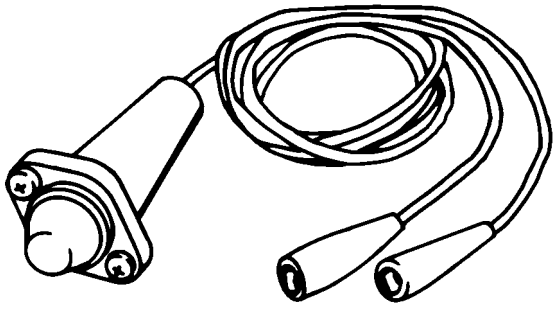
Priming Engines with Oil

IMPORTANT: This applies to all power packages that have not been run within 6 months, replacement of partial engines or after rebuilding an engine.

Tools Required



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91-52024A1 Remote Starter Switch

1. Fill crankcase to proper level with recommended engine oil.
2. Remove spark plugs.
3. Leave ignition Key in “OFF” position.
4. Connect remote starter switch to large 12V terminal (RED battery cable) and small terminal (YELLOW-RED wire) on starter motor.
   a. If Remote Starter Switch is not available, disconnect PURPLE wire from ignition coil before using key switch to crank the engine over. Tape terminal on Purple wire to prevent it from touching ground.
5. Crank engine over for 15 seconds, then allow starter motor to cool for 1 minute. Watch that starter motor does not overheat.
6. Repeat until a total of 45 seconds of crank time is achieved.
7. Remove Remote Starter Switch.
   a. If key switch was used, reconnect Purple wire to ignition coil.
8. Install spark plugs and wires.
9. With cooling water being supplied to seawater pump, start engine.

Power Steering Fluid

Use Quicksilver Power Trim and Steering Fluid, or automatic transmission Fluid (ATF), Dexron III.

Coolant for Closed Cooling System

⚠CAUTION

Alcohol or Methanol base antifreeze or plain water, are not recommended for use in fresh water section of cooling system at any time.

We recommend that the coolant section of closed cooling system be filled with Quicksilver Pre-Mixed Engine Coolant. In areas where the possibility of freezing does not exist, it is permissible to use a solution of rust inhibitor and water (mixed to manufacturer's recommendations).

Maintaining Crankcase Oil Level

Overfilled Engine Crankcase

Overfilled crankcases (oil level being too high) can cause a fluctuation or drop in oil pressure and rocker arm "clatter" on MerCruiser engines. The over-full condition results in the engine crankshaft splashing and agitating the oil, causing it to foam (become aerated). The aerated oil causes the hydraulic valve lifters to "bleed down." This, in turn, results in rocker arm "clatter" and loss of engine performance, due to the valves not opening properly.

Care must be taken when checking engine oil level. Oil level must be maintained between the ADD mark and the FULL mark on the dipstick. To ensure that you are not getting a "false reading," make sure the following steps are done before checking the oil level.

- Boat "at rest" in the water, or
- If boat is on a trailer, raise or lower bow until the boat is setting at the approximate angle that it would be if setting "at rest" in the water.
- Allow sufficient time for oil to drain into the crankcase if engine has just been run or oil has just been added.

Checking Engine Oil Level/Filling

IMPORTANT: ENGINE CRANKCASE OIL MUST BE CHECKED AT INTERVALS SPECIFIED IN "MAINTENANCE SCHEDULE" CHART. It is normal for an engine to use a certain amount of oil in the process of lubrication and cooling of the engine. The amount of oil consumption is greatly dependent upon engine speed, with consumption being highest at wide-open-throttle and decreasing substantially as engine speed is reduced.

1. Allow oil to drain back into oil pan - approximately 5 minutes.
2. Remove dipstick. Wipe clean and reinstall. Push dipstick all the way into dipstick tube.
3. Remove dipstick and note the oil level.
4. Oil level must be between the FULL and ADD marks.
5. If oil level is below ADD mark, proceed to Steps 6 and 7.
6. Remove oil filler cap from valve rocker arm cover.
7. Add required amount of oil to bring level up to, but not over, the FULL mark on dipstick.

Changing Oil and Filter

1. Start engine and run until it reaches normal operating temperatures.

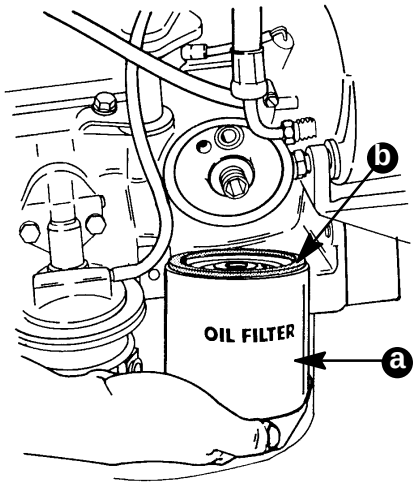
IMPORTANT: Change oil when engine is warm from operation, as it flows more freely, carrying away more impurities.

2. Stop engine.
3. Remove drain plug from oil pan or from oil drain hose.

NOTE: *If drain plug is not accessible because of boat construction, oil may be removed through dipstick tube, using a Quicksilver Crankcase Oil Pump.*

4. After oil has drained completely, reinstall drain plug (if removed) and tighten securely.
5. Remove and discard oil filter and its sealing ring.

6. Coat sealing ring on new filter with engine oil, and install. Tighten filter securely (following filter manufacturer's instructions). Do not over-tighten.



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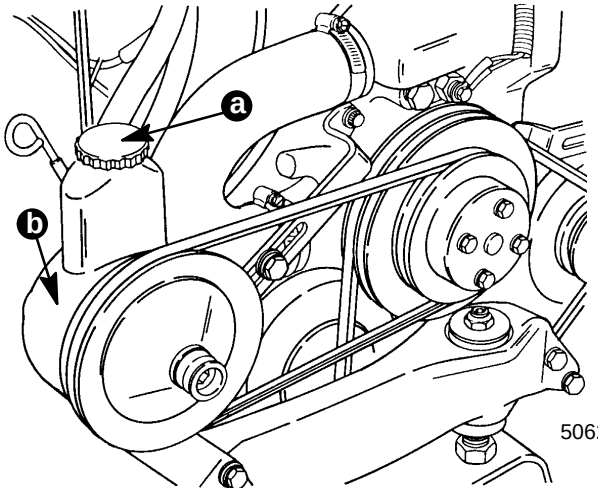
a - Oil Filter
b - Sealing Ring

7. Fill crankcase with oil.
8. Start engine and check for leaks.

Maintaining Power Steering Pump Fluid Level

With Engine Warm

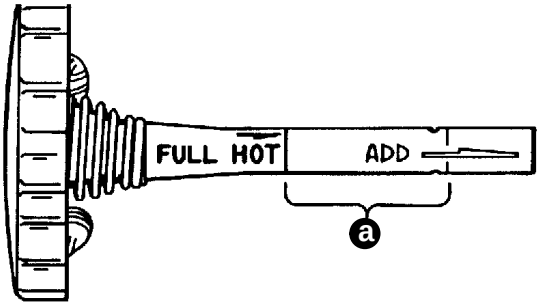
1. Stop engine and position drive unit so that it is straight back.
2. Remove fill cap/dipstick from power steering pump and note fluid level.



50629

a - Fill Cap/Dipstick
b - Power Steering Pump

3. Level should be between the FULL HOT mark and ADD mark on dipstick.



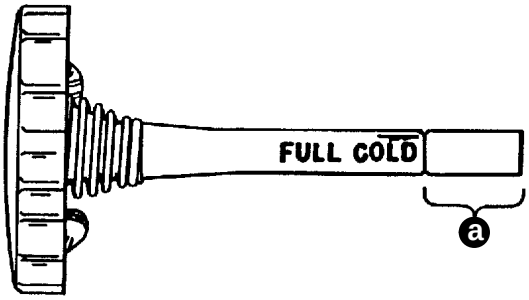
72518

a - Proper Fluid Level with Engine Warm

4. If level is below ADD mark, but fluid is still visible in pump reservoir, add required amount of Quicksilver Power Trim and Steering Fluid or automatic transmission fluid (ATF), Dexron, or Dexron II, through fill cap opening, to bring level up to FULL HOT mark on dipstick. DO NOT OVERFILL.
5. If fluid is not visible in reservoir, a leak exists in the power steering system. Find cause and correct.

With Engine Cold

1. With engine stopped, position drive unit so that it is straight back.
2. Remove fill cap/dipstick from power steering pump and note fluid level.
3. Level should be between FULL COLD mark and bottom of dipstick.



72519

a - Proper Fluid Level with Engine Cold

4. If level is below bottom of dipstick, but fluid is still visible in pump reservoir, add required amount of Quicksilver Power Trim and Steering Fluid or automatic transmission fluid (ATF), Dexron, or Dexron II, through fill cap opening, to bring level up to FULL COLD mark on dipstick. DO NOT OVERFILL.
5. If fluid is not visible in reservoir, a leak exists in the power steering system. Find cause and correct.

Filling and Bleeding Power Steering System

IMPORTANT: Power steering system must be filled exactly as explained in the following to be sure that all air is bled from the system. All air must be removed, or fluid in pump may foam during operation and be discharged from pump reservoir. Foamy fluid also may cause power steering system to become spongy, which may result in poor boat control.

1. With engine stopped, position drive unit so that it is straight back. Remove fill cap/dipstick from power steering pump. Add Quicksilver Power Trim and Steering Fluid or automatic transmission fluid (ATF), Dexron, or Dexron II, as required, to bring level up to FULL COLD mark on dipstick.

IMPORTANT: Use only Quicksilver Power Trim and Steering Fluid or automatic transmission fluid (ATF), Dexron, or Dexron II in power steering system.

2. Turn steering wheel back and forth to end of travel in each direction several times, then recheck fluid level and add fluid, if necessary.
3. Install vented fill cap.

⚠ CAUTION

DO NOT operate engine without water being supplied to seawater pickup pump, or pump impeller may be damaged and subsequent overheating damage to engine may result.

4. Start engine and run at fast idle (1000-1500 RPM) until engine reaches normal operating temperature. During this time, turn steering wheel back and forth to end of travel in each direction several times.
5. Position drive unit so that it is straight back and stop engine. Remove fill cap from pump. Allow any foam in pump reservoir to disperse, then check fluid level and add fluid, as required, to bring level up to FULL HOT mark on dipstick. DO NOT OVERFILL**.** Reinstall fill cap securely.

IMPORTANT: Drive unit must be positioned straight back and power steering fluid must be hot to accurately check fluid level.

6. If fluid is still foamy (in Step 5), repeat Steps 4 and 5 until fluid does not foam and level remains constant.

Maintaining Closed Cooling Coolant Level

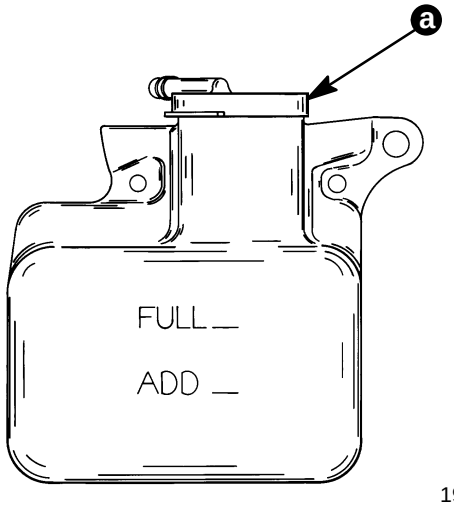
⚠ WARNING

Allow engine to cool down before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

1. Coolant level in heat exchanger should be full (to bottom of filler neck).

IMPORTANT: When reinstalling pressure cap, be sure to tighten it until it contacts stop on filler neck.

2. Coolant level should be between the ADD and FULL marks on coolant recovery reservoir with the engine at normal operating temperature.



193-HR

a - Coolant Recovery Reservoir

Flushing Cooling System

If engine is operated in salty, polluted, or mineral-laden water, flush cooling system (preferably after each use) to reduce corrosion and prevent the accumulation of deposits in the system. Thoroughly flush cooling system prior to storage.

⚠ WARNING

When flushing cooling system with boat out of the water, be certain that area in vicinity of propeller is clear and that no person is standing nearby. As a precautionary measure, it is recommended that propeller be removed.

⚠ CAUTION

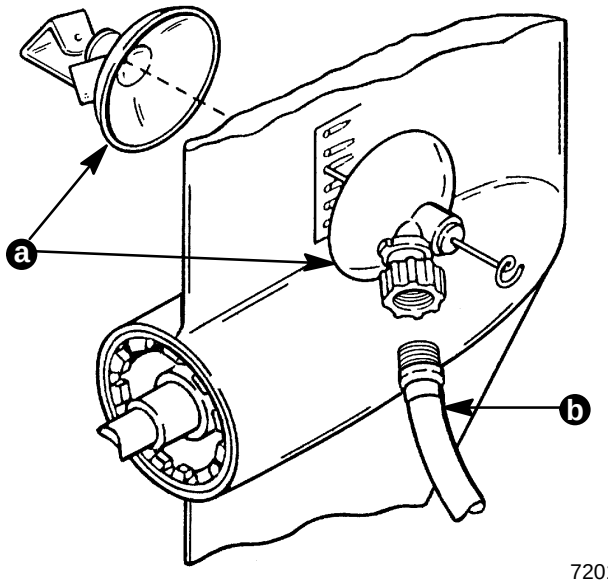
To prevent engine or stern drive unit damage DO NOT run engine or drive unit without water being supplied to water intake openings on gear housing, and to seawater pickup pump if so equipped.

1. Connect flushing attachment as follows:

NOTE: *If flushing cooling system with boat in water, raise drive unit to trailer position and install flushing attachment. Lower drive unit to full IN/DOWN position.*

   a. Install Quicksilver Flushing Attachment (or equivalent) over water intake openings in gear housing.

   b. Connect hose between flushing attachment and water tap.



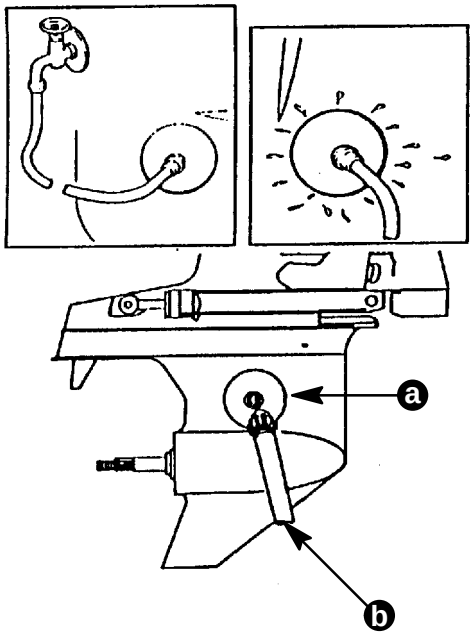
72012

a - Quicksilver Flushing Attachment
b - Garden Hose

⚠ CAUTION

If cooling system is to be flushed with boat in the water, seacock (if so equipped) must be closed, or water inlet hose must be disconnected and plugged to prevent water from flowing into boat.

2. Partially open water tap(s) (approximately 1/2 maximum capacity) and allow drive unit and cooling system to fill completely. Do not use full tap water pressure.



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a - Quicksilver Flushing Attachment
b - Water To Drive Unit

NOTE: *Drive unit is full when water is discharged out of drive unit, and/or seawater section of closed cooled system is full when water is discharged through propeller.*

⚠ CAUTION

Do not run engine above 1500 RPM when flushing. Suction created by seawater pickup pump may collapse flushing hose, causing engine to overheat.

3. Place remote control lever in NEUTRAL position and start the engine.

⚠ CAUTION

Watch temperature gauge at dash to ensure the engine does not overheat.

4. Operate engine at idle speed in NEUTRAL gear for 10 minutes or until discharge water is clear, then stop engine.
5. Shut off water tap(s).
6. Remove hose and flushing attachment from drive unit.:

NOTE: *If flushing cooling system with boat in water, raise drive unit to trailer position, to remove flushing attachment. Lower drive unit to full IN/DOWN position after completion.*

7. Follow instructions “a” or “b.”

⚠ CAUTION

If boat is in the water, seacock (if so equipped) must remain closed until engine is to be re-started, to prevent contaminated water from flowing back into cooling system. If boat is not fitted with a seacock, water inlet hose must remain disconnected and plugged, to prevent water from flowing into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel with the warning that the seacock must be opened or the water inlet hose reconnected prior to starting the engine.

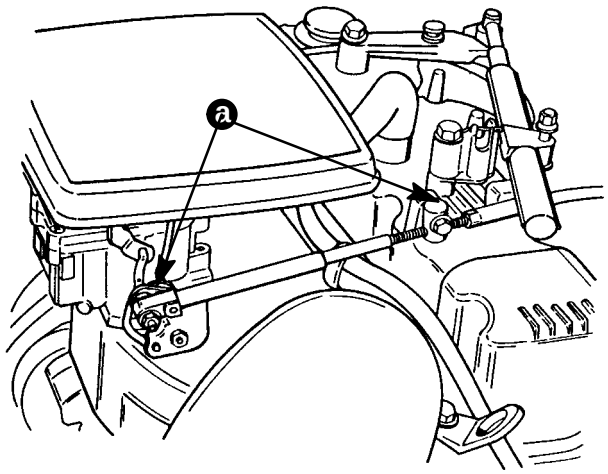
a. **If equipped with seacock:** Observing precaution above, open seacock.

b. **If NOT equipped with seacock:** Observing precaution above, remove plug from seawater inlet hose and reconnect seawater inlet hose. Tighten hose clamps securely.

Lubrication

Lubricate pivot points with SAE 30W motor oil and cable guide contact surfaces with Quicksilver 2-4-C Marine Lubricant with Teflon.

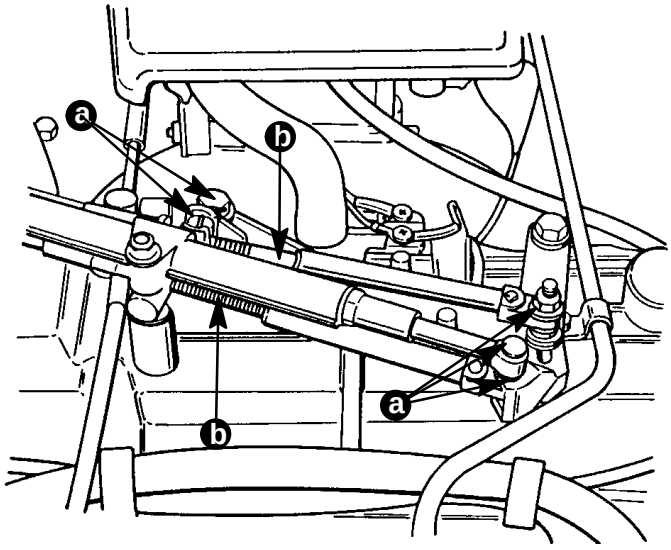
Throttle Cable



50626

a - Pivot Points

Shift Cable



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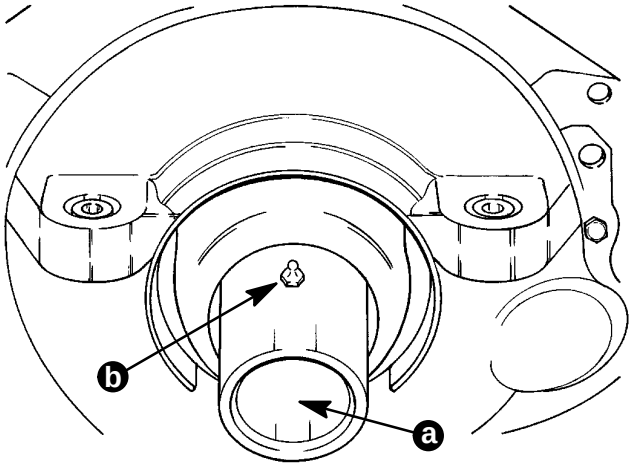
a - Pivot Points
b - Guide Contact Surface

Engine Coupler/U-Joint Shaft Splines

Lubricate coupler and splines with Quicksilver Engine Coupler Spline Grease (92- 816391A4).

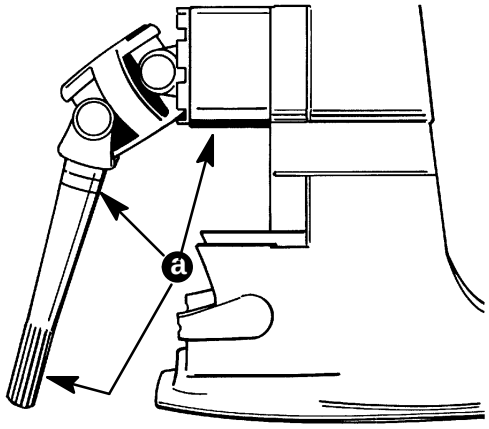
IMPORTANT: Stern Drive Unit does not have to be removed to grease coupler.

NOTE: *Refer to MerCruiser Stern Drive Service Manual for stern drive unit removal and installation if necessary.*



72017

a - Quicksilver Engine Coupler Spline Grease
b - Use Grease Fitting if Drive Is Installed



72530

a - Quicksilver Engine Coupler Spline Grease (If Drive Has Been Removed)

Audio Warning System

Maintenance

Maintenance inspection is the owner's responsibility and must be performed at intervals specified, following:

Fresh Water Areas - Every 50 Hours of operation or 60 days (whichever comes first)

Salt Water Areas - Every 25 hours of operation or 30 days (whichever comes first)

NOTE: *Operation in salt water is considered severe service.*

1. Check buzzer mounting screws, heat switch and oil pressure switch for adequate tightness. Tighten, if loose, but DO NOT over-tighten.
2. Check all wiring connections to be sure that they are tight and sealed where necessary.

Cold Weather or Extended Storage

Precautions

⚠ WARNING

BE CAREFUL while working on fuel system; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF and do not smoke or allow sources of spark and/or open flames in the area.

⚠ WARNING

To prevent a potential fire hazard, be sure that engine compartment is well ventilated and that there are no gasoline vapors present during starting or fogging of engine.

⚠ CAUTION

DO NOT operate engine without water flowing through seawater pickup pump, as pump impeller may be damaged and subsequent overheating damage to engine or stern drive unit may result.

⚠CAUTION

Seawater section of cooling system MUST BE COMPLETELY drained for winter storage, or immediately after cold weather use, if the possibility of freezing temperatures exists. Failure to comply may result in trapped water causing freeze and/or corrosion damage to engine.

⚠CAUTION

If boat is in the water, seacock (water inlet valve), if so equipped, must be closed until engine is to be re-started, to prevent water from flowing back into cooling system and/or boat. If boat is not fitted with a seacock, water inlet hose must be disconnected and plugged to prevent water from flowing back into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel of the boat with the warning that the seacock must be opened or the water inlet hose reconnected prior to starting engine.

IMPORTANT: Observe the following information to ensure complete draining of cooling system:

- **Engine must be as level as possible.**
- **A wire should be repeatedly inserted into all drain holes to ensure there are no obstructions in passages. Remove petcock, if necessary, to insert wire completely into drain hole.**

IMPORTANT: To prevent threads in manifolds, elbows and cylinder blocks from rusting out during storage, reinstall plugs using Quicksilver Perfect Seal on threads. Never leave drain plugs out during storage.

NOTE: *If possible, place a container under drains and hoses to prevent water from draining into boat.*

⚠CAUTION

If engine is equipped with Closed Cooling System, Closed Cooling section must be kept filled with a solution of ethylene glycol antifreeze and water (mix antifreeze to manufacturer's recommended proportions to protect engine to lowest temperature to which it will be exposed). DO NOT USE PROPYLENE GLYCOL antifreeze in closed cooling section. Seawater section, however, must be drained completely.

⚠CAUTION

A discharged battery can be damaged by freezing.

Layup

NOTICE
Refer to "Cold Weather or Extended Storage," "Precautions," in this section, BEFORE proceeding.

1. Fill fuel tank(s) with fresh gasoline that does not contain alcohol and a sufficient amount of Quicksilver Gasoline Stabilizer for Marine Engines.

IMPORTANT: If boat is to be placed in storage (with fuel containing alcohol in fuel tanks), carburetors must be run dry at idle RPM. Fuel tanks should be drained completely and Quicksilver Gasoline Stabilizer and Conditioner added to any fuel remaining in the tank. Also, refer to "Fuel Specifications," see Table of Contents.

2. Replace all fuel filters
3. Start engine and check for fuel leaks.
4. Run engine sufficiently to heat it to normal operating temperature; shut off engine and change oil and filter.
5. If boat has been operated in salty, polluted or mineral-laden waters, flush cooling system.
6. Remove flame arrestor assembly and restart engine. While operating engine at fast idle (1000-1500 RPM), fog internal surfaces of induction system and combustion chambers by squirting approximately 8 ounces (227 grams) of Quicksilver Storage Seal or SAE 20W engine oil into carburetor bores. Stall engine by squirting last 2 ounces (57 grams) of Storage Seal or oil rapidly into carburetor. Turn ignition to OFF.
7. Close fuel shutoff valve, if so equipped.
8. Clean flame arrestor and crankcase ventilation hoses and reinstall.
9. Lubricate all items outlined in "Lubrication."
10. Drain seawater section of cooling system, outlined in "Draining Instructions," following.
11. **Closed Cooling System Models:** Test coolant to ensure that it will withstand lowest temperature expected during storage.
12. Service batteries.

13. Clean outside of engine and repaint any areas required with Quicksilver Primer and Spray Paint. After paint has dried, spray Quicksilver Corrosion and Rust Preventive Type II or wipe down with Quicksilver Storage Seal or SAE 20W engine oil.
14. For drive unit, refer to appropriate stern drive manual.

⚠CAUTION

Stern drive unit should be stored in full "down" position. Universal Joint bellows may develop a "set" if unit is stored in raised position and may fail when unit is returned to service.

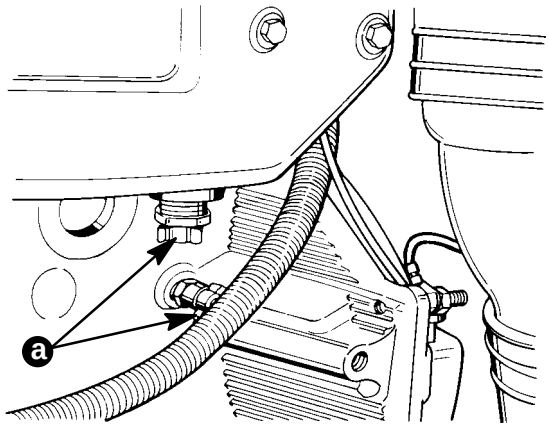
Draining Instructions

Draining Seawater (Raw-Water) Cooled Models

NOTICE

Refer to "Cold Weather or Extended Storage," "Precautions," in this section, BEFORE proceeding.

1. Engine must be as level as possible to ensure complete draining of cooling system.
2. Remove drain plugs from cylinder block and manifold.



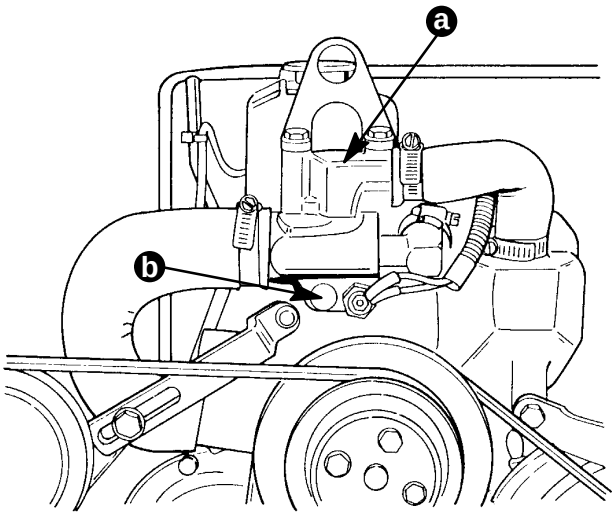
71424

a - Drain Plug (Port and Starboard)

3. Repeatedly clean out drain holes using a stiff piece of wire. Do this until entire system is drained.

NOTE: *It may be necessary to lift, bend, or lower hoses to allow water to drain completely when hoses are disconnected.*

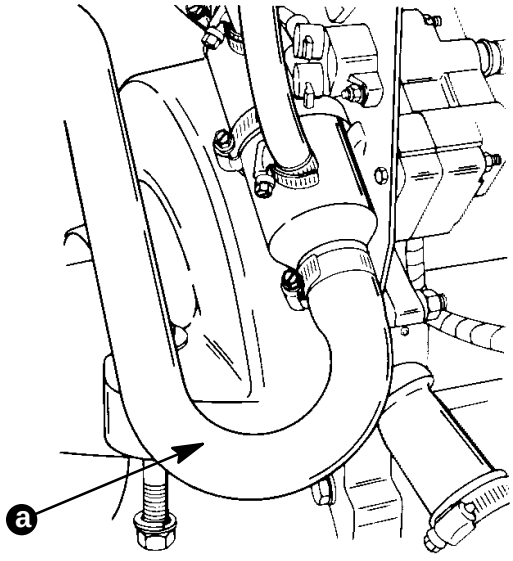
4. Remove and lower the hoses to allow them drain



50628

a - Inlet Hose
b - Circulating Pump Hose

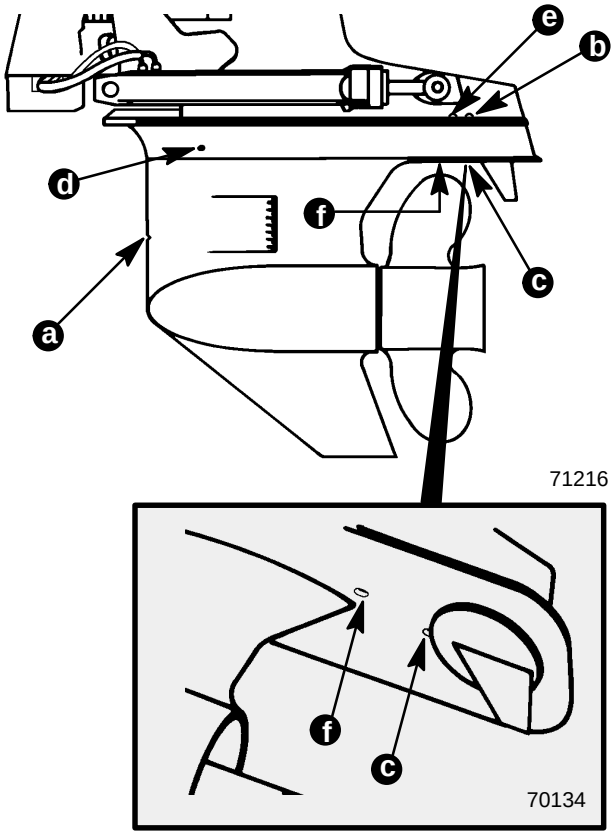
5. Remove the power steering fluid cooler seawater hose, as shown.



71422

a - Hose, Seawater Pump-to-Cooler

6. Insert a small wire (repeatedly) to make sure that vent holes and water drain holes and passages (as shown) are unobstructed and open.



a - Speedometer Pitot Tube
b - Trim Tab Cavity Vent Hole
c - Trim Tab Cavity Drain Passage
d - Gear Housing Water Drain Hole (One Each - Port and Starboard)
e - Gear Housing Cavity Vent Hole
f - Gear Housing Cavity Drain Hole

7. Crank engine over SLIGHTLY, with starter motor, to purge any water trapped in seawater pickup pump. DO NOT ALLOW ENGINE TO START.

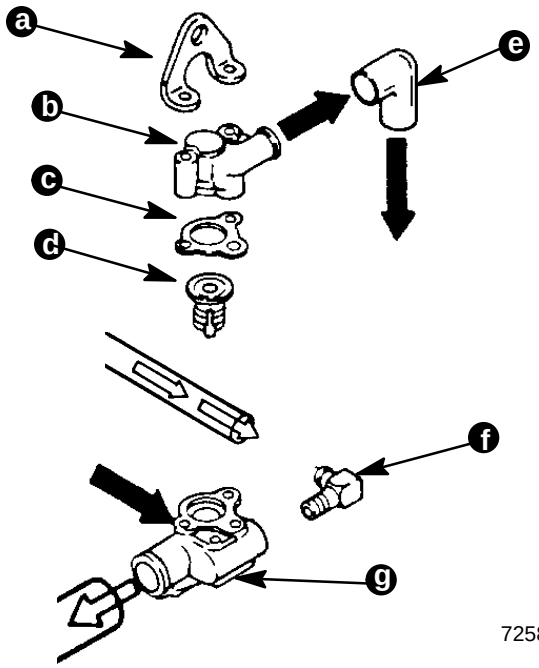
⚠CAUTION

If boat is in the water or is to remain in the water, seacock (if so equipped) must remain closed until engine is to be restarted, to prevent water from flowing back into cooling system. If boat is not fitted with a seacock, seawater inlet hose must remain disconnected and plugged, to prevent water from flowing into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel with the warning that the seacock must be opened or the seawater inlet hose reconnected prior to starting the engine.

8. After cooling system has been drained completely, coat threads of drain plugs with Quicksilver Perfect Seal and reinstall. Tighten drain plugs securely. Reconnect hoses and tighten all hose clamps securely. **If NOT equipped with seacock:** seawater inlet hose must remain disconnected and plugged until engine is to be restarted.

IMPORTANT: MerCruiser recommends that propylene glycol antifreeze (nontoxic and biodegradable, which makes it friendly to lakes and rivers) be used in sea-water section of the cooling system for cold weather or extended storage. Make sure that the propylene glycol antifreeze contains a rust inhibitor and is recommended for use in marine engines. Be certain to follow the propylene glycol manufacturer's recommendations.

9. For additional assurance against freezing and rust, remove the thermostat cover and thermostat. Fill the engine seawater cooling system with a mixture of antifreeze and tap water mixed to manufacturer's recommendation to protect engine to the lowest temperature to which it will be exposed during cold weather or extended storage. Using a new gasket, reinstall thermostat and cover. Tighten cover bolts to 30 lb. ft. (41 N·m).



a - Lifting Eye
b - Cover
c - Gasket
d - Thermostat
e - Hose
f - Fitting
g - Housing

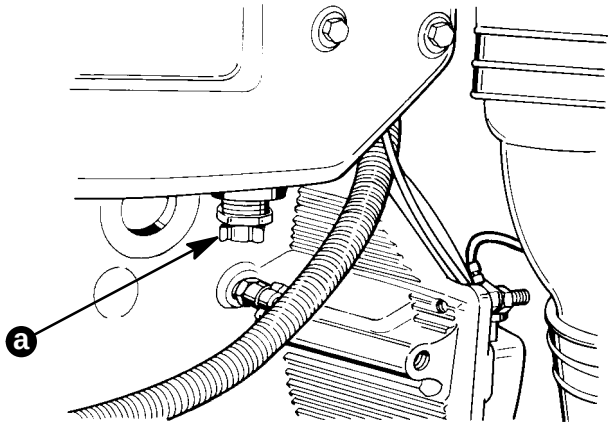
NOTE: *Hoses shown removed only to indicate flow. Do not remove hoses.*

Draining Seawater Section of Closed Cooled (Coolant) Models

NOTICE

Refer to "Cold Weather or Extended Storage," "Precautions," in this section, BEFORE proceeding.

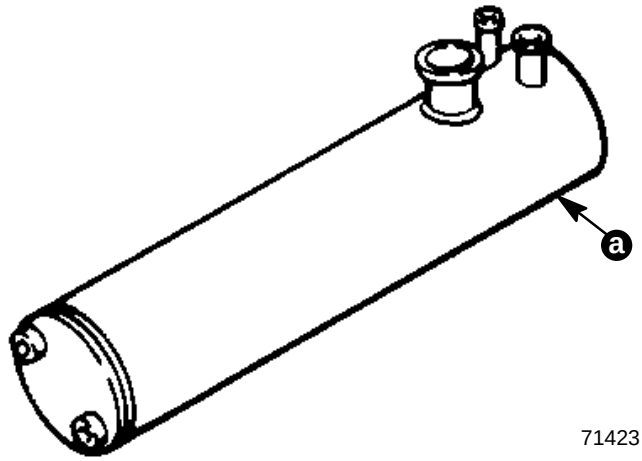
1. Close seacock (if so equipped) or disconnect and plug seawater inlet hose.
2. Check that engine is as level as possible to ensure complete draining of cooling system.
3. Remove drain plugs from exhaust manifold.



71424

a - Drain Plug (Port and Starboard)

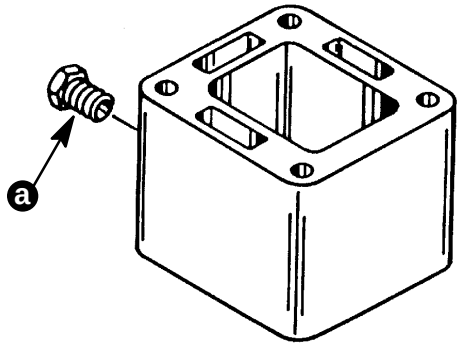
4. Remove aft (rear) drain plug from heat exchanger.



71423

a - Drain Plug

5. If equipped with 3 in. (76 mm) or 6 in. (152 mm) risers, remove drain plug as shown from riser.



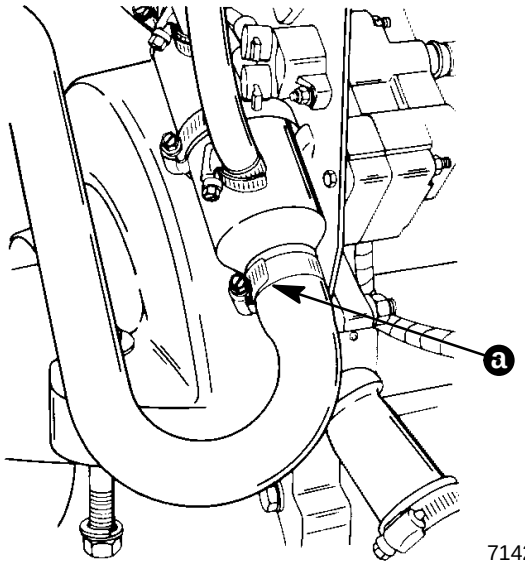
73175

a - Drain Plug (Removed)

6. Repeatedly clean out drain holes using a stiff piece of wire. Do this until entire system is drained.

NOTE: *It may be necessary to lift, bend, or lower hoses to allow water to drain completely when hoses are disconnected.*

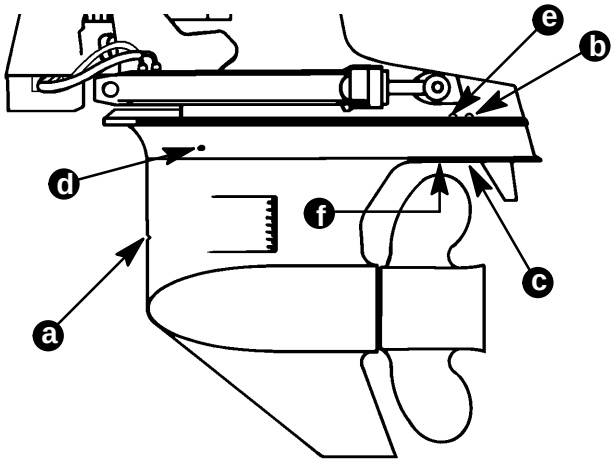
7. Remove the power steering fluid cooler seawater hose, as shown.



71422

a - Hose, Seawater Pump-to-Cooler

8. Insert a small wire (repeatedly) to make sure that vent holes and water drain holes and passages (as shown) are unobstructed and open.



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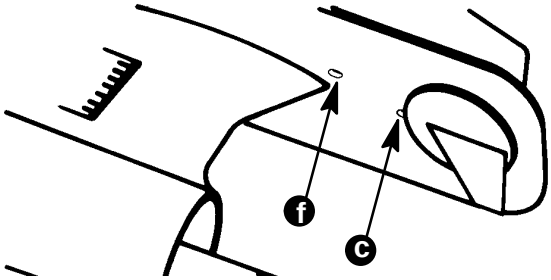


70134

a - Speedometer Pitot Tube
b - Trim Tab Cavity Vent Hole
c - Trim Tab Cavity Drain Passage
d - Gear Housing Water Drain Hole
(One Each - Port and Starboard)
e - Gear Housing Cavity Vent Hole
f - Gear Housing Cavity Drain Hole

9. Crank engine over SLIGHTLY with starter motor to purge any water trapped in seawater pickup pump. DO NOT ALLOW ENGINE TO START.

⚠CAUTION

If boat is in the water or is to remain in the water, seacock (if so equipped) must remain closed until engine is to be restarted, to prevent water from flowing back into cooling system. If boat is not fitted with a seacock, seawater inlet hose must remain disconnected and plugged, to prevent water from flowing into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel with the warning that the seacock must be opened or the seawater inlet hose reconnected prior to starting the engine.

10. After seawater section of cooling system has been drained completely, coat threads of drain plugs with Quicksilver Perfect Seal and reinstall. Tighten drain plugs securely. Reconnect hoses and tighten all hose clamps securely. **If NOT equipped with seacock:** seawater inlet hose must remain disconnected and plugged until engine is to be restarted.

Recommissioning

NOTICE

Refer to "Cold Weather or Extended Storage," "Precautions," in this section, BEFORE proceeding.

1. Check that all cooling system hoses are connected and tight and all petcocks and drain plugs are installed and tight.
2. Inspect all drive belts.
3. Perform all lubrication and maintenance specified for completion "At Least Once Yearly" in maintenance chart, except items which were performed at time of engine layup.
4. For drive unit, refer to appropriate stern drive manual.
5. Install fully charged battery. Clean battery cable clamps and terminals to help retard corrosion.
6. Start engine and closely observe instrumentation to ensure that all systems are functioning properly.
7. Carefully inspect entire engine for fuel, oil, water and exhaust leaks.
8. Check fuel pump sight tube.
9. Check steering system and shift and throttle controls for proper operation.

Cause	Special Information
1. Moisture on ignition components	1. Distributor cap or spark plug wires arcing
2. Battery, electrical connections, damaged wiring	
3. Ignition switch	
4. Shift interrupter switch (Alpha One Models Only)	
5. Shorted tachometer	5. Disconnect tachometer and try again
6. Ignition timing	
7. Spark plugs	7. Fouled, burned, cracked porcelain
8. Spark plug wires	8. Faulty insulation, broken wires
9. Cracked or dirty distributor cap	
10. Faulty ignition components	10. Check components
11. Engine synchronizer (if equipped) hooked up in series on purple ignition wire (dual engines only)	11. Synchronizers must be hooked up directly at coil terminal (parallel chute)

TROUBLESHOOTING

Table of Contents

	Page
Precautions	1C- 1
Used Spark Plug Analysis	1C- 2
Spark Plug Analysis	1C- 2
Normal Condition	1C- 2
Chipped Insulator	1C- 2
Wet Fouling (Oil Deposits)	1C- 2
Cold Fouling	1C- 3
Overheating	1C- 3
High Speed Glazing	1C- 3
Scavenger Deposits	1C- 3
Pre-Ignition Damage	1C- 4
Reversed Coil Polarity	1C- 4
Splashed Deposits	1C- 4
Mechanical Damage	1C- 4
Poor Boat Performance and/or Poor Maneuverability	1C- 5
Improper Full Throttle Engine RPM	1C- 6
RPM Too High	1C- 6
RPM Too Low	1C- 6
Engine Cranks Over But Will Not Start Or Is Hard To Start	1C- 7
Important Information	1C- 7
Breaker Points Ignition (No Spark)	1C- 7
Digital Distributorless Ignition System (DDIS)	1C- 8
EST Ignition System Check	1C- 10
Test Description	1C- 10
Engine Will Not Crank Over/Starter Inoperative	1C- 13
Charging System Inoperative	1C- 13
Noisy Alternator	1C- 14
Fuel System Rich	1C- 14
Fuel System Lean	1C- 15
Carburetor Malfunction	1C- 15
Engine Runs Poorly At Idle	1C- 16
Engine Acceleration Is Poor	1C- 18
Engine Runs Poorly At High RPM	1C- 19
Poor Fuel Economy	1C- 20
Radio Noise	1C- 21
Troubleshooting With Vacuum Gauge	1C- 21
Miscellaneous	1C- 22
Instrumentation Malfunction	1C- 22
Engine Noise	1C- 23
Important Information	1C- 23
Valve Cover Area	1C- 23
Cylinder Area	1C- 23
Camshaft Area	1C- 24
Crankshaft Area	1C- 25
Miscellaneous	1C- 26
Oil Pressure	1C- 27
Low Oil Pressure	1C- 28
High Oil Pressure	1C- 28
Excessive Oil Consumption	1C- 29
Water in Engine	1C- 30
Important Information	1C- 30
Water In Crankcase	1C- 30
Water On Top Pistons	1C- 31
Engine Overheats (Mechanical)	1C- 32
Engine Overheats (Cooling System)	1C- 33
Poor, Erratic, or No Assist	1C- 34
Noisy Pump	1C- 35
Fluid Leaks	1C- 35
Insufficient Water Flow from Alpha One Stern Drive Unit Seawater Pickup Pump	1C- 36

NOTICE

Refer to "Precautions" BEFORE proceeding with troubleshooting.

Precautions

⚠WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠WARNING

Be careful when cleaning flame arrestor and crankcase ventilation hose; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

⚠WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or flame in the area while changing fuel filter. Wipe up any spilled fuel immediately.

⚠WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel pump or fuel filter base can crack casting and/or cause a fuel leak. Follow specific procedure, given in Section 4 of this manual, for all fuel line connections.

⚠WARNING

Make sure no fuel leaks exist before closing engine hatch.

⚠CAUTION

DO NOT operate engine without cooling water being supplied to water pickup holes in gear housing, or water pump impeller will be damaged and subsequent overheating damage may result.

⚠CAUTION

DO NOT operate engine without water being supplied to seawater pickup pump on engine, or pump impeller may be damaged and subsequent overheating damage to engine may result. Engine may be operated with boat out of water, if instructions under “Running Engine with Boat Out of Water,” following, are completed.

⚠WARNING

When running engine with boat out of water, be certain that area in vicinity of propeller is clear and that no person is standing nearby. As a precautionary measure, it is recommended that the propeller be removed.

⚠CAUTION

DO NOT run engine above 1500 RPM, as suction created by seawater pickup pump may collapse water supply hose and cause engine to overheat.

⚠WARNING

Be sure that engine compartment is well ventilated and that no gasoline vapors are present to prevent the possibility of a FIRE or EXPLOSION.

⚠WARNING

DO NOT leave helm unattended while performing idle speed adjustment.

Used Spark Plug Analysis

Use the following illustrations for determining serviceability of spark plug. Spark plug condition also can suggest a variety of possible engine malfunctions and, therefore, can indicate needed engine repairs. When old plugs are replaced, replace entire set. Perform plug service only on those plugs suitable for additional service, using the following procedures:

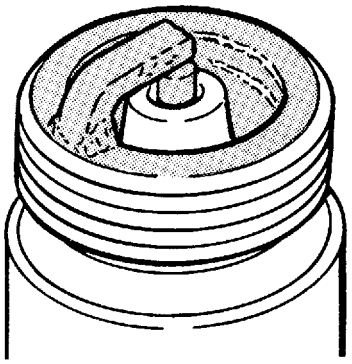
1. Remove any oil deposits with solvent and dry plugs thoroughly.
2. Open electrode gap wide enough to permit cleaning and filing.
3. Remove combustion deposits from firing end of spark plug with a plug cleaner. Blow off with compressed air to remove abrasives.
4. File electrode surfaces to restore clean, sharp edges. Again remove filings with compressed air.
5. Reset gap to specifications by bending only side electrode with proper tool.

IMPORTANT: When working on engine, spark plug holes and carburetor throat should be kept covered to prevent foreign objects from entering combustion chamber.

Spark Plug Analysis

Normal Condition

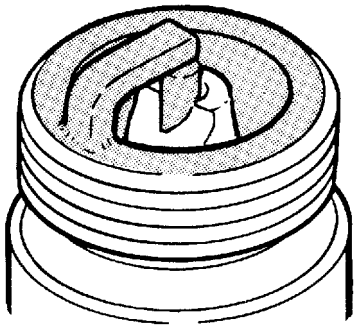
Few deposits are present and probably will be light tan or gray in color. This plug shows that plug heat range is compatible with engine, and engine is electrically and mechanically in good running condition. With proper plug servicing (clean, file and re-gap), this plug can be reinstalled with good results.



72420

Chipped Insulator

Chipped insulator usually results from careless plug re-gapping. Under certain conditions, severe detonation also can split insulator firing ends. Plug must be replaced.

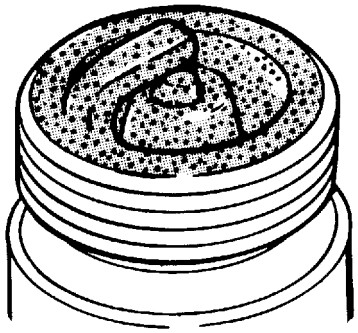


72420

Wet Fouling (Oil Deposits)

Plug becomes shorted by excessive oil entering combustion chamber, usually in engine with many hours of operation. Worn piston rings, cylinder walls, valve guides or valve stem seals are causes of oil entering combustion chamber. Only engine repairs will permanently relieve oil wet fouling.

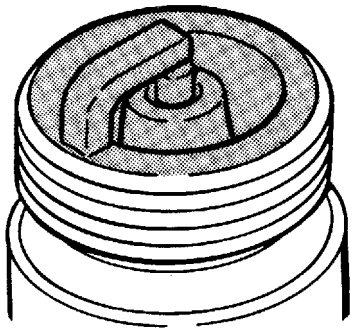
IMPORTANT: New engines or recently overhauled engines may wet foul plugs before normal oil control is achieved with proper break-in procedures. Such fouled plugs may be serviced (clean, file and re-gap) and reinstalled.



72420

Cold Fouling

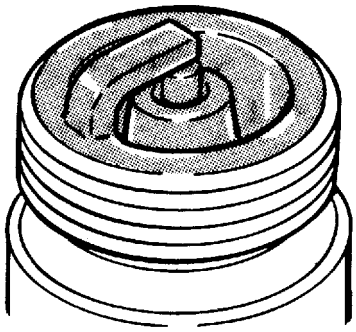
Dry, black deposits indicate rich fuel mixture or weak ignition. Clogged flame arrestor, flooding carburetor, sticky choke or weak ignition components all are probable causes. If, however, only one or two plugs in set are fouled, check for sticking valves or bad ignition leads. After correcting cause, service (clean, file and re-gap) plugs and reinstall.



72421

High Speed Glazing

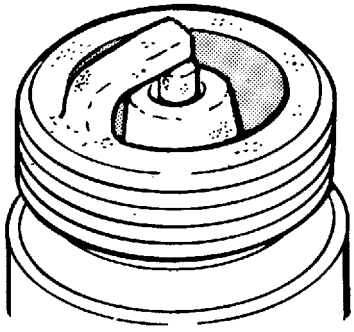
Insulator has yellowish, varnish-like color, indicating that temperatures suddenly have risen, usually during hard, fast acceleration under heavy load. Normal deposits do not get a chance to blow off. Instead, they melt and form a conductive coating. Replace plugs. If condition recurs, use colder heat range plug and service plugs more frequently.



72421

Overheating

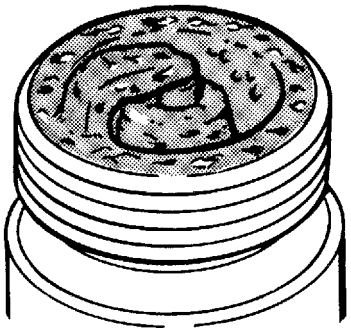
Insulator is dull white or gray and appears blistered. Electrodes are eroded and there is an absence of deposits. Check that correct plug heat range is being used. Also check for over-advanced ignition timing, cooling system malfunction, lean fuel/air mixtures, leaking intake manifold or sticking valves. Replace spark plugs.



72421

Scavenger Deposits

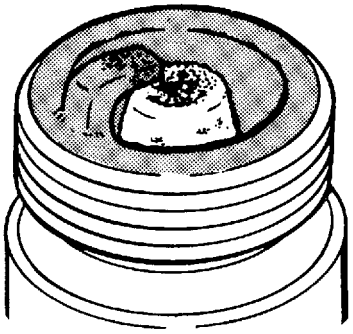
Powdery white or yellow deposits are built up on shell, insulator and electrodes. This is normal appearance with certain branded fuels. Accumulation on ground electrodes and shell areas may be unusually heavy, but may be easily chipped off. Plugs can be serviced (clean, file and re-gap) and reinstalled.



72422

Pre-Ignition Damage

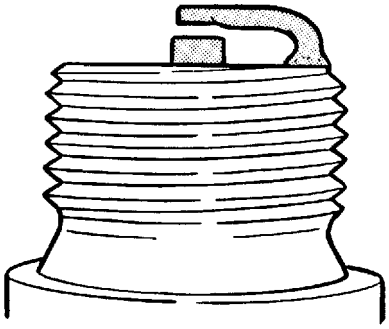
Pre-ignition damage is caused by excessive high temperatures. Center electrode melts first, followed by ground electrode. Normally, insulators are white but may be dirty if plug has been misfiring. Check for correct plug heat range, advanced ignition timing, lean fuel mixture, incorrect fuel used, malfunctioning cooling system, leaking intake manifold or lack of lubrication.



72422

Reversed Coil Polarity

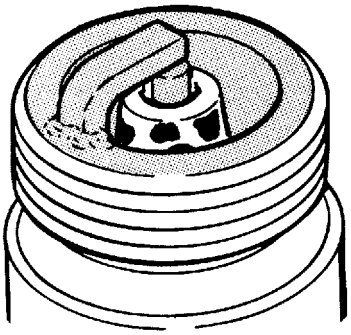
Concave erosion of ground electrode is an indication of reversed polarity. Center electrode will show only normal wear. Engine will misfire and idle rough. To correct, reverse primary coil leads. Replace spark plugs.



72422

Splashed Deposits

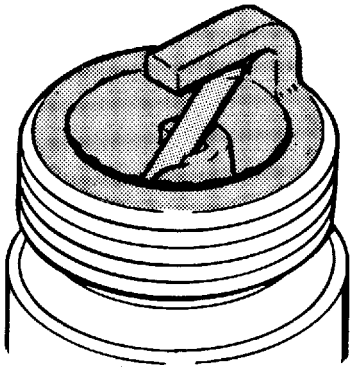
Spotted deposits, which sometimes occur after long delayed tune-up, accumulate after a long period of misfiring. When normal combustion temperatures are restored, upon installation of new plugs, deposits loosen from top of piston and head and are thrown against hot insulator. Clean and service plugs and reinstall.



72423

Mechanical Damage

Mechanical damage to spark plug firing end is caused by foreign object in combustion chamber. Because of valve overlap, small objects can travel from one cylinder to another. Check all cylinders, intake manifold and exhaust material to prevent further damage.



72423

Poor Boat Performance and/or Poor Maneuverability

Symptom	Cause
1. Bow too low	1. A. Improper drive unit trim angle
	B. Improper weight distribution
	C. Boat is underpowered
	D. Permanent or power hook in boat bottom
	E. False bottom full of water
	F. Improperly adjusted trim tabs (after planes)
	G. Dirty boat bottom (marine growth)
2. Bow too high	2. A. Improper drive unit trim angle
	B. Propeller pitch too great
	C. Dirty boat bottom (marine growth)
	D. Poor running engine
	E. Improper weight distribution
	F. Rocker in boat bottom
	G. False bottom full of water
	H. Improperly adjusted trim tabs (after planes)
3. Propeller ventilating	3. A. Drive unit installed too high on transom
	B. Dirty or rough boat bottom
	C. Damaged propeller; pitch too small; diameter too small
	D. Keel located too close to propeller or too deep in the water
	E. Water pickup or thru hull fittings located too close to propeller
	F. Hook in boat bottom
	G. Propeller plugged up with weeds

Improper Full Throttle Engine RPM

RPM Too High

Cause	Special Information
1. Propeller	1. Damaged; pitch too low; diameter too small; propeller hub slipping.
2. Boat	2. Water pickup or thru hull fittings mounted too close to propeller (ventilation); keel located too close to propeller and/or too deep in the water (ventilation). Drive installed too high on transom; wrong gear ratio.
3. Operation	3. Unit trimmed out too far.
4. Engine coupler slipping	

RPM Too Low

Cause	Special Information
1. Propeller	1. Damaged; pitch too great; diameter too great.
2. Boat	2. Dirty or damaged bottom; permanent or power hook in bottom; false bottom full of water. Drive installed too low on transom; wrong gear ratio.
3. Operation	3. Unit trimmed in too far.

Engine Cranks Over But Will Not Start Or Is Hard To Start

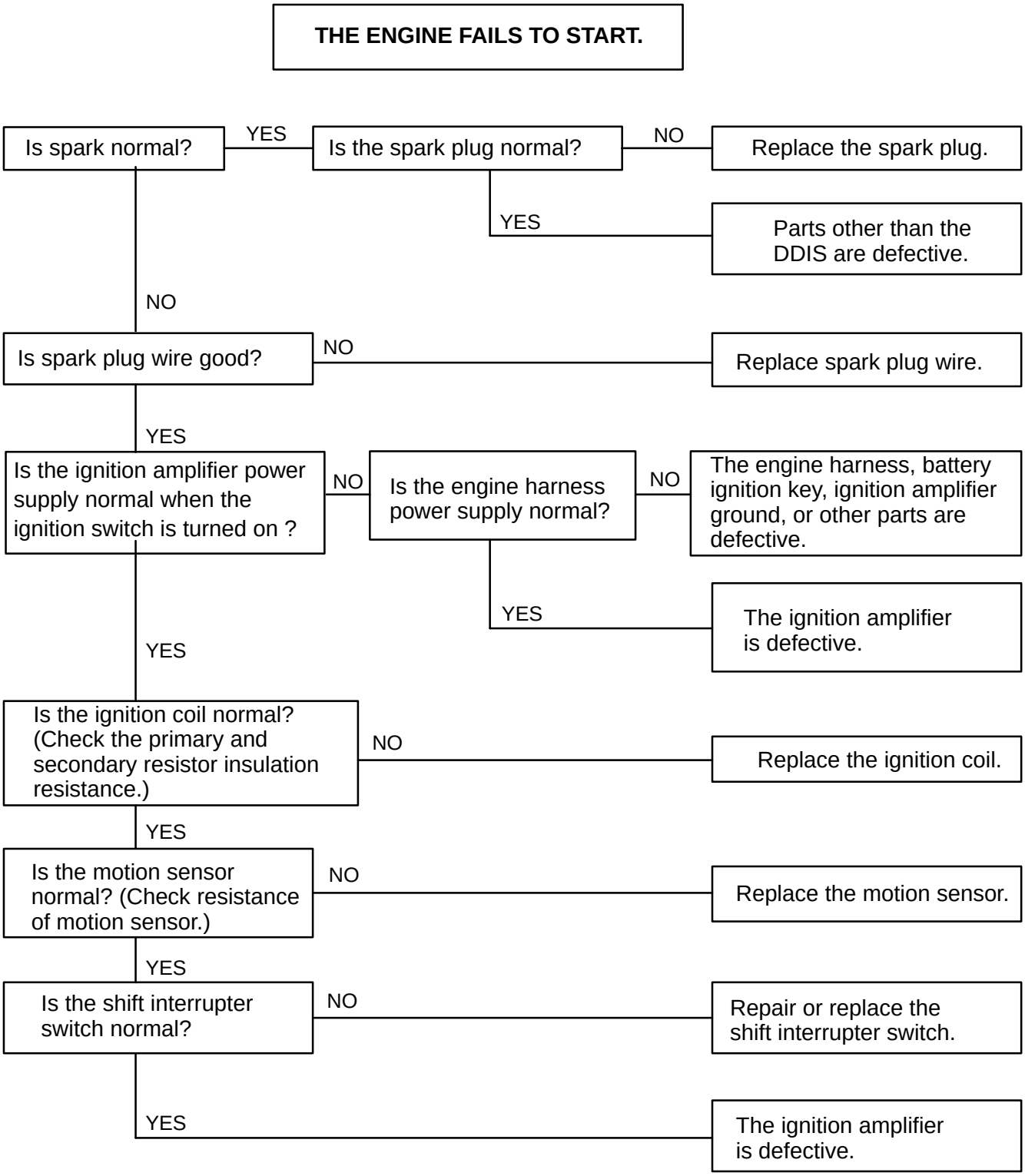
Important Information

1. First, determine which engine system is causing the problem. To make an engine run, basic components fuel, spark (ignition), and compression are required. If all three components are present, the engine should run. If any one of the three are missing, weak, or arriving at the wrong time the engine will not run.
2. Determine if there is fuel present by looking down the carburetor venturi while actuating throttle. There should be a stream of fuel coming out of the accelerator pump nozzles if the carburetor has fuel.
3. Check ignition system operation. Remove coil wire from tower on distributor cap. Hold coil wire near ground and check for spark while cranking engine over. Repeat procedure with spark plug wires. If there is spark at the spark plug wires, remove the spark plugs and make sure they are correct type and heat range, and not fouled or burned.
4. Run a compression check on engine to make sure the engine is mechanically sound.

Breaker Points Ignition (No Spark)

Cause	Special Information
1. Moisture on ignition components	1. Distributor cap or spark plug leads arcing.
2. Battery, electrical connections, damaged wiring	
3. Ignition switch	3. May run in start position and lose spark in the run position.
4. Shift interrupter switch	
5. Shorted tachometer	5. Disconnect tachometer and try again.
6. Ignition timing	6. May crank over hard, backfire, or try to run back wards
7. Faulty ignition resistor wire or bypass wire	
8. Ignition points improperly gapped, burned or dirty	
9. Spark plugs	9. Fouled, burned, cracked porcelain
10. Spark plug wires	10. Faulty insulation, broken wires
11. Cracked or dirty distributor cap or rotor	
12. Coil	
13. Condenser	
14. Shift interrupter switch	

Digital Distributorless Ignition System (DDIS)



Index

THE ENGINE FAILS TO IDLE.

Is spark normal? YES → Is the spark plug normal? NO → Replace the spark plug.

Is the spark plug normal? YES → Parts other than the DDIS are defective.

Is spark normal? NO → Is spark plug wire good? NO → Replace spark plug wire.

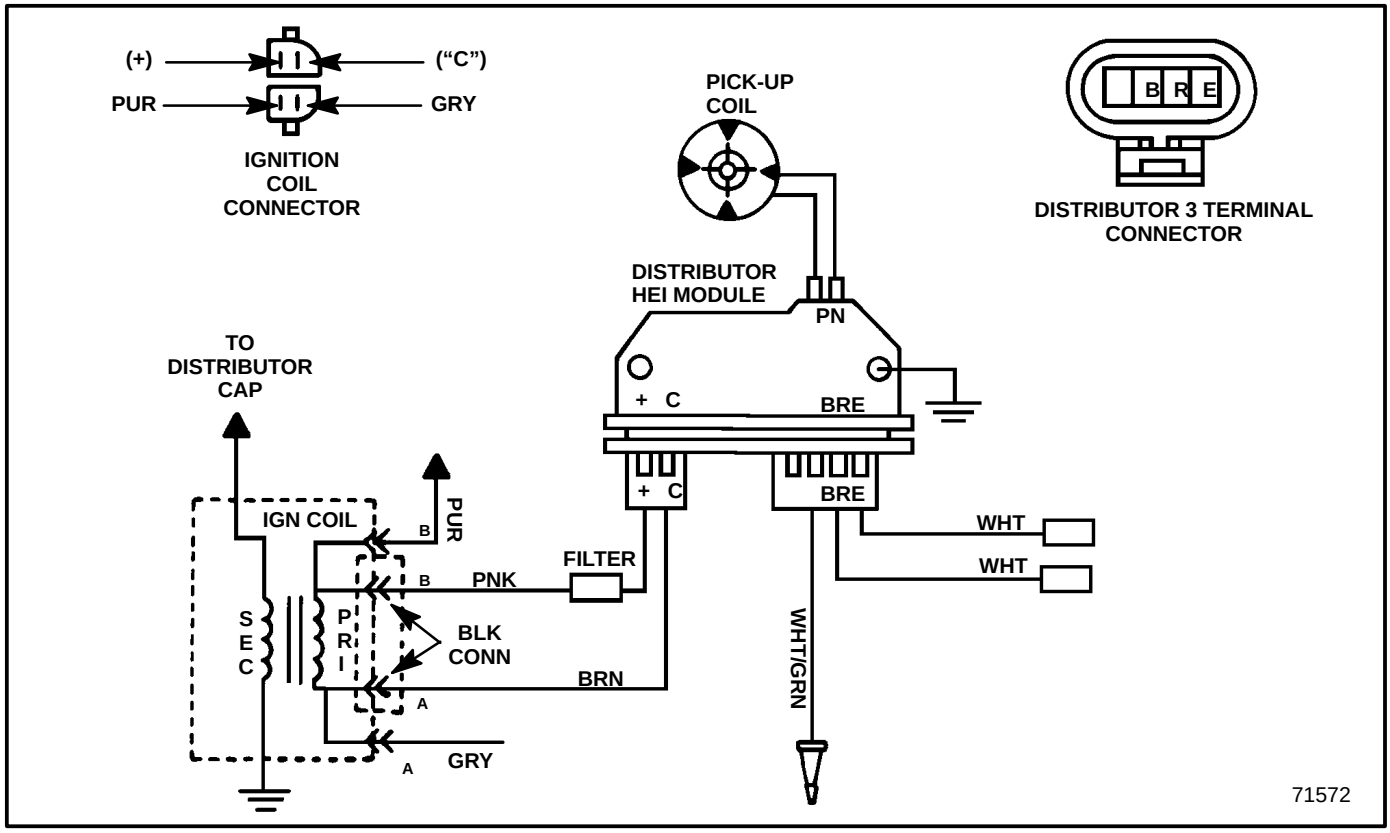
Is spark plug wire good? YES → Is the ignition coil normal? (Check the primary and secondary resistor insulation resistance.) NO → Replace the ignition coil.

Is the ignition coil normal? YES → Is the shift interrupter switch normal? NO → Repair or replace the shift interrupter switch.

Is the shift interrupter switch normal? YES → The ignition amplifier is defective.

MIS-FIRE AT HIGH SPEED

Operating above recommended RPM range. YES → Reduce speed/throttle-setting (see “Overspeed Prevention Control”, 4B-12.



EST Ignition System Check

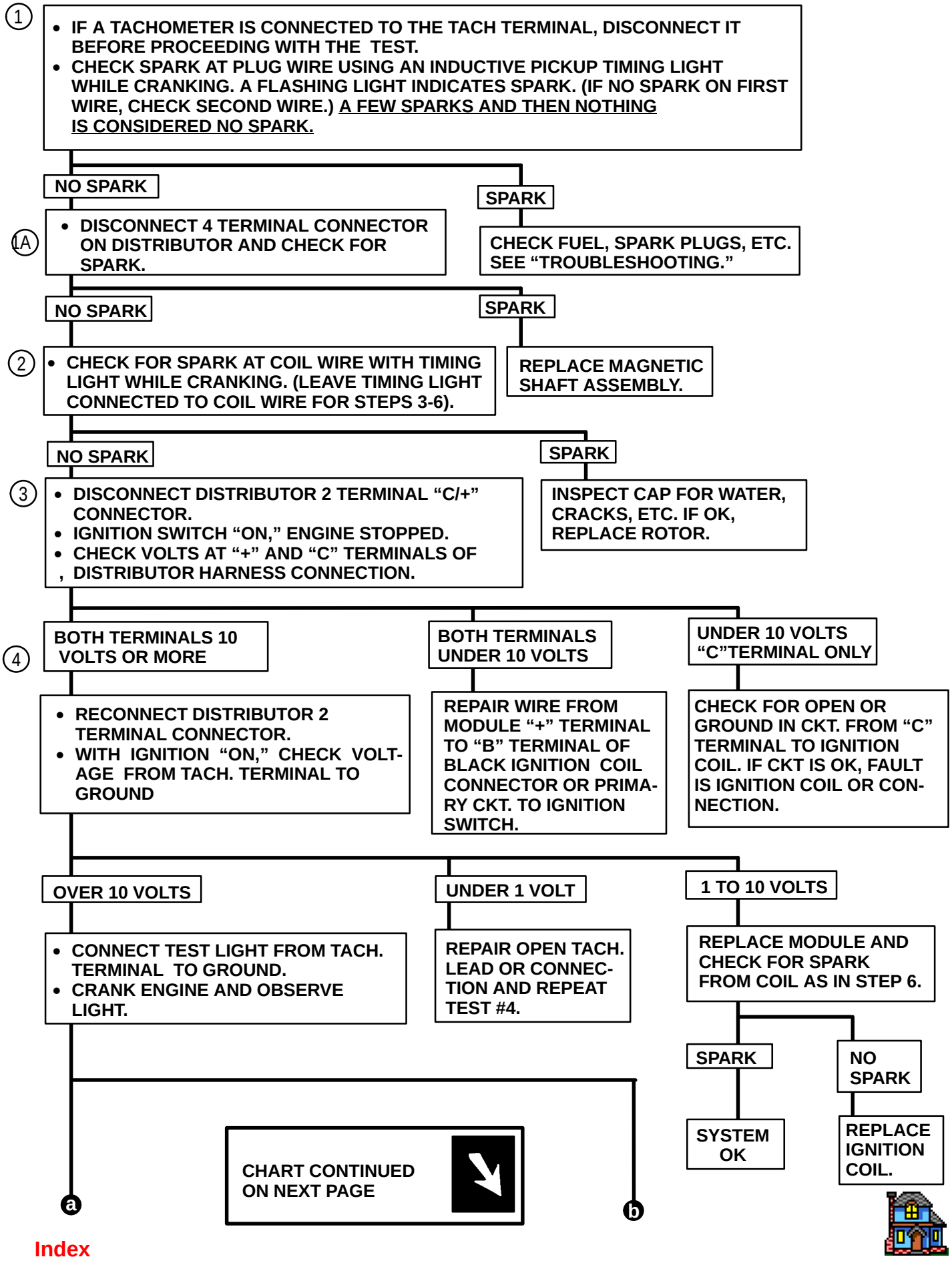
Test Description

Numbers below refer to circled numbers on the diagnostic chart.

1. Two wires are checked, to ensure that an open is not present in a spark plug wire.
   a. If spark occurs with EST connector disconnected, pick-up coil output is too low for EST operation.
2. A spark indicates the problem must be the distributor cap or rotor.
3. Normally, there should be battery voltage at the "C" and "+" terminals. Low voltage would indicate an open or a high resistance circuit from the distributor to the coil or ignition switch. If "C" terminal voltage was low, but "+" terminal voltage is 10 volts or more, circuit from "C" terminal to ignition coil or ignition coil primary winding is open.
4. Checks for a shorted module or grounded circuit from the ignition coil to the module. The distributor module should be turned "OFF," so normal voltage should be about 12 volts. If the module is turned "ON," the voltage would be low, but above 1 volt. This could cause the ignition coil to fail from excessive heat. With an open ignition coil primary winding, a small amount of voltage will leak through the module from the "BAT" to the "TACH" terminal.
5. Applying a voltage (1.5 to 8 volts) to module terminal "P" should turn the module "ON" and the "tach" terminal voltage should drop to about 7-9 volts. This test will determine whether the module or coil is faulty or if the pick-up coil is not generating the proper signal to turn the module "ON." This test can be performed by using a DC battery with a rating of 1.5 to 8 volts. The use of the test light is mainly to allow the "P" terminal to be probed more easily. Some digital multi-meters can also be used to trigger the module by selecting ohms, usually the diode position. In this position the meter may have a voltage across its terminals which can be used to trigger the module. The voltage in the ohm's position can be checked by using a second meter or by checking the manufacturer's specification of the tool being used.
6. This should turn "OFF" the module and cause a spark. If no spark occurs, the fault is most likely in the ignition coil because most module problems would have been found before this point in the procedure. A module tester could determine which is at fault.

Index

Ignition System Check(1 of 2)



Index

Ignition System Check (2 of 2)

CHART CONTINUED FROM PREVIOUS PAGE

a

LIGHT ON STEADY

b

LIGHT BLINKS

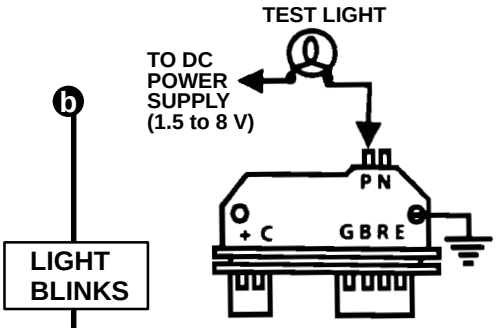


Fig. 1

5

- DISCONNECT DISTRIBUTOR 4 TERMINAL CONNECTOR.
- REMOVE DISTRIBUTOR CAP.
- DISCONNECT PICK-UP COIL CONNECTOR FROM MODULE.
- CONNECT VOLTMETER FROM TACH. TERMINAL TO GROUND.
- IGNITION "ON."
- INSULATE A TEST LIGHT PROBE TO 1/4, FROM TIP AND NOTE VOLTAGE, AS TEST LIGHT IS MOMENTARILY CONNECTED FROM A VOLTAGE SOURCE (1.5 TO 8 V) TO MODULE TERMINAL "P" (CHART 1 OF 2 PAGE 11).

REPLACE IGNITION COIL AND RECHECK FOR SPARK WITH TIMING LIGHT. IF STILL NO SPARK, REINSTALL ORIGINAL COIL AND REPLACE DISTRIBUTOR MODULE.

VOLTAGE DROPS

NO DROP IN VOLTAGE

6

- CHECK FOR SPARK FROM COIL WIRE WITH TIMING LIGHT AS TEST LIGHT IS REMOVED FROM MODULE TERMINAL

CHECK MODULE GROUND. IF OK, REPLACE MODULE.

NO SPARK

SPARK

- REPLACE IGNITION COIL AND REPEAT STEP 5.

- IS ROTATING POLE PIECE STILL MAGNETIZED?

NO SPARK

SPARK

YES

NO

IGNITION COIL REMOVED IS OK, REINSTALL COIL AND CHECK COIL WIRE FROM DIST. CAP. IF OK, REPLACE DISTRIBUTOR MODULE.

SYSTEM OK

CHECK PICK-UP COIL OR CONNECTIONS (COIL RESISTANCE SHOULD BE 500-1500 OHMS AND NOT GROUNDED.)

REPLACE POLE PIECE AND SHAFT ASSEMBLY.

Index

Engine Will Not Crank Over/Starter Inoperative

Cause	Special Information
1. Remote control lever not in neutral position	
2. Battery charge low; damaged wiring; loose electrical connections	
3. Circuit breaker tripped	
4. Blown fuse	
5. Ignition switch	
6. Slave solenoid	
7. Faulty neutral start safety switch	7. Open circuit
8. Starter solenoid	
9. Starter motor	
10. Mechanical engine malfunction	

Charging System Inoperative

Cause	Special Information
1. Loose or broken drive belt	
2. Engine RPM too low on initial start	2. Rev engine to 1500 RPM
3. Loose or corroded electrical connections	
4. Faulty battery gauge	4. Best way to test is to replace gauge
5. Battery will not accept charge	5. Low electrolyte or failed battery
6. Faulty alternator or regulator	
7. Refer to SECTION 4C for complete “Charging System” diagnosis procedures	

Noisy Alternator

Cause	Special Information
1. Loose mounting bolts	
2. Drive belt	2. Worn, frayed, loose
3. Loose drive pulley	
4. Worn or dirty bearings	
5. Faulty diode trio or stator	

Fuel System Rich

Cause	Special Information
1. Warm engine carburetor percolation	1. Fuel boils out of float bowl when shut off and warm. Floods intake manifold.
2. Clogged flame arrestor	
3. Automatic choke not opening	
4. Float adjustment	
5. Float leaks or is saturated with fuel	
6. Needle and seat leaking	
7. Carburetor gaskets leaking	
8. Excessive fuel pump pressure	8. Unseats needle and seat
9. Cracked or porous carburetor body	

Fuel System Lean

Cause	Special Information
1. Empty fuel tank	
2. Fuel shut-off valve closed (if equipped)	
3. Vapor lock	3. Engine will not start after warm engine shut down
4. Automatic choke	4. Stuck open, wrong adjustment
5. Fuel tank vent plugged	5. Engine will start initially. After a short time of running, engine will stall and will not restart for a period of time. Can verify it is a vent problem by running engine with filler cap loose. Fill cap will act as a vent.
6. Air leak on suction side of fuel system	6. Sucks air into fuel system reducing fuel volume
7. Plugged or pinched fuel line	
8. Fuel pump	8. Low pump pressure

Carburetor Malfunction

Symptoms	Cause
1. Flooding	1. A. Needle and seat
	B. Float adjustment
	C. Saturated float
	D. Gaskets leaking
	E. Cracked fuel bowl
	F. Fuel percolation
	G. Automatic choke
2. Rough idle	2. A. Idle RPM too low
	B. Idle mixture screws
	C. Idle passages dirty
	D. Throttle valves not closing
	E. Engine flooding
	F. Vacuum leak
	G. Throttle body heat passages plugged
3. Hesitation or acceleration flatness	3. A. Accelerator pump
	B. Leaking gaskets
	C. Automatic choke
	D. Power piston or power valve
	E. Throttle valves

Index

Carburetor Malfunction (continued)

	F. Throttle body heat passages plugged
	G. Main metering jets
	H. Float adjustment
	I. Secondary air valve wind-up
4. Engine surges	4. A. Main metering jets
	B. Leaking gaskets
	C. Float adjustment
	D. Saturated float
	E. Power piston or valve
	F. Throttle valves
5. Low top speed or lack of power	5. A. Power piston or valve
	B. Float adjustment
	C. Main metering jets
	D. Leaking gaskets
6. Poor cold engine operation	6. A. Idle RPM too low
	B. Idle mixture screws
	C. Throttle valves
	D. Automatic choke
	E. Engine flooding
7. Engine stalls	7. A. Idle RPM too low
	B. Idle mixture screws
	C. Engine flooding
	D. Automatic choke
	E. Dirt in carburetor
	F. Accelerator pump
	G. Leaking gaskets
8. Hard starting	8. Refer to “Engine Starts Hard”

Engine Runs Poorly At Idle

Cause	Special Information
1. Clogged flame arrestor	
2. Improper idle fuel mixture adjustment	
3. Engine floods at idle	3. A. Problem in ignition system causing the engine to run rough
	B. Idle mixture screw adjusted incorrectly
	C. Bad needle and seat

Engine Runs Poorly At Idle (continued)

	D. Incorrect float level drop E. If carburetor (2 bbl. only) has a solid needle, replace with a spring loaded needle
4. Moisture on ignition components	4. Cap or spark plug wires arcing
5. Water in fuel	
6. Low grade or stale fuel	
7. Incorrect ignition timing	
8. Automatic choke	
9. Spark plugs	9. Fouled, burned, cracked porcelain
10. Spark plug wires	10. Insulation breakdown, wires broken
11. Defective coil	
12. Cracked or dirty distributor cap	
13. Incorrect float level	
14. Dirty carburetor	
15. Vacuum leak	15. Leak at manifold or carburetor base
16. Incorrect fuel pump pressure	16. Too low - can't supply the carburetor Too high - unseats the needle and seat
17. Low compression	17. Also check for blown head gasket
18. Loose or worn distributor	18. Timing changes
19. Water leaking into cylinders	19. Head gasket, exhaust manifold, cracked head or valve seat
20. Loose or broken engine mounts	

Engine Acceleration Is Poor

Cause	Special Instructions
1. Also refer to “Poor Boat Performance”	
2. Idle mixture screws	
3. Incorrect ignition timing	
4. Incorrect distributor or amplifier advance curve	4. Refer to Section 4B
5. Accelerator pump	5. Check for stream of raw fuel from accelerator pump discharge nozzle, when opening throttle with engine shut off
6. Cracked or dirty distributor cap or rotor	
7. Vacuum leak	7. Intake manifold or carburetor base
8. Spark plugs	8. Fouled, burned; wrong heat range; cracked porcelain
9. Float adjustment	
10. Dirty carburetor	
11. Low compression	

Engine Runs Poorly At High RPM

Cause	Special Information
1. Also refer to “Poor Boat Performance”	
2. Crankcase overfilled with oil	2. Check oil level with boat at rest in the water.
3. Anti-siphon valve (if equipped)	3. Restricting fuel supply
4. Plugged fuel tank vent	
5. Fuel supply	5. Refer to “Carburetor Malfunctions” (See “Table of Contents”)
6. Ignition timing	
7. Low grade of fuel or water in the fuel	
8. Spark plugs	8. Fouled, burned, cracked porcelain, incorrect heat range
9. Spark plug wires	9. Poor insulation, broken wires
10. Distributor cap or rotor	10. Dirty or cracked
11. Coil	
12. Distributor	12. Excessive play in shaft
13. Engine overheating	13. Refer to “Engine Overheats”
14. Low compression	14. Worn valves, rings, cylinders, etc.
15. Restricted exhaust	

Poor Fuel Economy

Cause	Special Information
1. Fuel leaks	
2. Operator habits	2. Prolonged idling; slow acceleration; failure to cut back on throttle once boat is on plane; boat over loaded; uneven weight distribution
3. Engine laboring	3. Bent, damaged, or wrong propeller. Water test boat for proper operating RPM at wide open throttle
4. Clogged flame arrestor	
5. Engine compartment sealed too tight	5. Not enough air for engine to run properly
6. Boat bottom	6. Dirty (marine growth), hook, rocker
7. Carburetor	7. Idle mixture settings, accelerator pump adjustments,linkage binding, choke adjustment, carburetor flooding over, main fuel jets
8. Improper fuel	
9. Crankcase ventilation system not working	
10. Engine needs tune-up	
11. Engine running too cold or too hot	
12. Plugged or restricted exhaust	
13. Engine	13. Low compression

Radio Noise

Cause	Special Information
1. A “popping” noise that will increase with engine RPM. Noise will stop as soon as engine is turned off.	1. Ignition System - wrong spark plugs; cracked distributor cap; cracked coil tower; leaking spark plug wires; moisture on ignition components
2. “High pitched whine” in the radio	2. Alternator - poor brush contact on the slip rings
3. A “hissing or crackling” noise when instruments are jarred with ignition on	3. Instrumentation - loose connections, or antennae wire routed too close to instruments
4. Varying unexplained noises	4. Accessories - bilge pump, bilge blower; fish finder; depth locator; cabin heater motor, etc. Disconnect one at a time until noise disappears.

Troubleshooting With Vacuum Gauge

Reading	Cause
1. Steady reading between 15-21 inches at idle RPM	1. Normal
2. Extremely low reading, but steady at idle RPM	2. Vacuum leak; incorrect timing; underpowered boat; faulty boat bottom
3. Fluctuates between high and low at idle RPM	3. Blown head gasket between two adjacent cylinders
4. Fluctuates 4 or 5 inches very slowly at idle RPM	4. Carburetor needs adjustment; spark plug gap too narrow;valves are sticking
5. Fluctuates rapidly at idle, steadies as RPM is increased	5. Valve guides are worn
6. Continuously fluctuates between low and normal reading at regular intervals at idle RPM	6. Burned or leaking valve

Miscellaneous

Cause	Special Information
1. Low grade or stale fuel	
2. Water in fuel	

Instrumentation Malfunction

Cause	Special Information
1. Faulty wiring, loose or corroded terminals	
2. Faulty key switch	2. Test, as outlined in SECTION 4D
3. Faulty gauge	3. Test, as outlined in SECTION 4D
4. Faulty sender	4. Test , As outlined in SECTION 4D

Engine Noise

Important Information

No definite rule or test will positively determine source of engine noise; therefore, use the following information only as a general guide to engine noise diagnosis.

1. Use a timing light to determine if noise is timed with engine speed or one-half engine speed. Noises timed with engine speed are related to crankshaft, rods, pistons, piston pins, and flywheel. Noises timed to one-half engine speed are valve train related.
2. The use of a stethoscope can aid in locating a noise source; however, because noise will travel to other metal parts not involved in the problem, caution must be exercised.
3. If you believe noise is confined to one particular cylinder, ground spark plug leads, one at a time. If noise lessens noticeably or disappears, it is isolated to that particular cylinder.
4. Try to isolate the noise to location in engine: front to back, top to bottom. This can help determine which components are at fault.
5. Sometimes noises can be caused by moving parts coming in contact with other components. Examples are: flywheel or coupler; exhaust flappers rattling against exhaust pipe; crankshaft striking (pan, pan baffle, or dipstick tube); rocker arm striking valve cover; and loose flywheel cover. In many cases if this is found to be the problem, a complete engine teardown is not necessary.
6. When noise is isolated to a certain area and component, removal and inspection will be required. Refer to proper sections of service manual for information required for service.
7. If noise cannot be distinguished between engine and drive unit, remove drive from boat. Run a water supply directly to engine. Run engine without the drive to determine if noise is still there.

Valve Cover Area

Location	Possible Cause
1. Valve cover area, timed to one-half engine speed, noise could be confined to one cylinder or may be found in any multitude of cylinders	1. A. Rocker arm striking valve cover B. Rocker arm out of adjustment C. Worn rocker arm D. Bent push rod E. Collapsed filter

Cylinder Area

Location	Possible Causes
1. Cylinder area, may be confined to one cylinder or found in more than one cylinder, timed to engine speed	1. A. Sticking valve B. Carbon build-up C. Connecting rod installed wrong D. Bent connecting rod E. Piston F. Piston rings G. Piston pin H. Cylinder worn

Index

Camshaft Area

Location	Possible Causes
1. Camshaft area, front of engine, timed to one half engine speed	1. A. Crankshaft timing sprocket B. Timing chain C. Fuel Pump D. Valve Lifter E. Cam Bearings
2. Camshaft area, center of engine, timed to one half engine speed	2. A. Fuel Pump B. Valve Lifter C. Cam bearing
3. Camshaft area, rear of engine, timed to one half engine speed	3. A. Distributor gear B. Valve lifter C. Cam bearings
4. Camshaft area, throughout engine, timed to one half engine speed	4. A. Loss of oil pressure B. Valve lifters C. Cam bearings

Crankshaft Area

Location	Possible Causes
1. Crankshaft area, front of engine, timed to engine speed	1. A. Crankshaft timing sprocket B. Timing chain C. Main bearing D. Rod bearing
2. Crankshaft area, center of engine, timed to engine speed	2. A. Crankshaft striking pan or pan baffle B. Main bearing C. Rod bearing
3. Crankshaft area, rear of engine, timed to engine speed	3. A. Loose flywheel cover B. Loose coupler C. Loose flywheel D. Main bearing E. Rod bearing
4. Crankshaft area, throughout engine, timed to engine speed	4. A. Loss of oil pressure B. Main bearings C. Rod bearings

Miscellaneous

Noise	Possible Cause
1. Engine spark knock	1. A. Advanced timing
	B. Low octane fuel
	C. Engine running hot
	D. Carbon deposits in engine
2. Popping through carburetor	2. A. Wrong ignition timing
	B. Carburetor set too lean
	C. Faulty accelerator pump
	D. Vacuum leak
	E. Valve adjustment
	F. Valve timing
	G. Burned or stuck valve
3. Hissing	3. A. Vacuum leak
	B. Leaking exhaust (manifolds or pipes)
	C. Loose cylinder heads
	D. Blown head gasket
4. Whistle	4. A. Vacuum leak
	B. Dry or tight bearing in an accessory
5. Sparks jumping	5. A. Leaking high tension lead
	B. Cracked coil tower
	C. Cracked distributor cap
6. Squeaks or squeals	6. A. Drive belt slipping
	B. Dry or tight bearing in an accessory
	C. Parts rubbing together
7. Rattling in exhaust pipe area	7. A. Exhaust shutters

Oil Pressure

1. Measuring oil pressure	1. Use a good automotive oil pressure test gauge. Do not rely on the oil pressure gauge in the boat.
2. Check engine oil level with boat at rest in the water	2. Oil level should be between the ADD and FULL marks
3. Oil level in crankcase above FULL mark	3. May cause loss of engine RPM, oil pressure gauge fluctuation, drop in oil pressure, and hydraulic valve lifter noise at high RPM
4. Oil level in crankcase below ADD mark	4. Low oil pressure; oil pressure gauge fluctuation; internal engine noise and/or damage
5. Change in oil pressure	5. This may be a normal condition. Oil pressure may read high in the cooler times of the day, and when engine is not up to operating temperature. As the air temperature warms up and engine is running at normal opening temperature, it is normal for oil pressure to drop.
6. Low engine oil pressure at idle	6. With modern engines and engine oils, low oil pressure readings at idle do not necessarily mean there is a problem. If valve lifters do not “clatter” (at idle), there is a sufficient volume of oil to lubricate all internal moving parts properly. The reason for the drop in oil pressure is that engine heat causes an expansion of the internal tolerances in the engine and, also, the oil will thinout somewhat from heat.
7. Low engine oil pressure at idle after running at a high RPM	7. Refer to No. 5 and 6, preceding
8. Boats with dual engines	8. It is not uncommon to see different oil pressure readings between the two engines, as long as both engines fall within specifications. Differences in oil pressure can be attributed to differences in engine tolerances, gauges, wiring, senders, etc.
9. Boats with dual stations	9. Refer to No. 8. preceding

Low Oil Pressure

Cause	Special Information
1. Low oil level in crankcase	
2. Defective oil pressure gauge and/or sender	2. Verify with an automotive test gauge. Refer to SECTION 4D for instrument testing.
3. Thin or diluted oil	3. Oil broken down; contains water or gas; wrong viscosity; engine running too hot or too cold; excessive idling in cold water (condensation)
4. Oil pump	4. Relief valve stuck open; pickup tube restricted; worn parts in oil pump; air leak on suction side of oil pump or pickup oil tube
5. Oil leak can be internal or external	5. Oil passage plugs leaking, cracked or porous cylinder block
6. Excessive bearing clearance	6. Cam bearings, main bearings, rod bearings

High Oil Pressure

Cause	Special Information
1. Oil too thick	1. Wrong viscosity, oil full of sludge or tar
2. Defective oil pressure gauge and/or sender	2. Verify with an automotive test gauge
3. Clogged or restricted oil passage	
4. Oil pump relief valve stuck closed	

Excessive Oil Consumption

Cause	Special Information
1. Normal consumption.	1. One quart of oil consumed in 5-15 hours of operation at wide-open-throttle (especially in a new or rebuilt engine) is normal
2. Oil leaks	2. Clean bilge, run engine with clean white paper on bilge floor, locate oil leak(s)
3. Oil too thin	3. Oil diluted or wrong viscosity
4. Oil level too high	
5. Drain holes in cylinder head plugged	5. Oil will flood valve guides
6. Defective valve seals	
7. Intake manifold gasket leaking	
8. Worn valve stems or valve guides	
9. Defective oil cooler (if so equipped)	9. Crack in cooler tubes
10. Defective piston rings	10. Glazed, scuffed, worn, stuck, improperly installed; ring grooves worn; improper break-in; wrong end gap
11. Defective cylinders	11. Out of round, scored, tapered, glazed; excessive piston to cylinder clearance; cracked piston
12. Excessive bearing clearance	

Water in Engine

Important Information

IMPORTANT: First determine location of water in engine. This information can be of great help when trying to determine where the water came from and how it got into the engine. The three most common problems are "water on top of pistons, water in crankcase oil, water in crankcase oil and on top of pistons."

The first step, after locating water, is to remove all the water from the engine by removing all spark plugs and pumping cylinders out by cranking engine over. Next change oil and filter. Now, start engine and see if problem can be duplicated. If problem can be duplicated, there more than likely is a mechanical problem. If the problem cannot be duplicated, the problem is either an operator error or a problem that exists only under certain environmental conditions.

If water is contained to cylinder(s) only, it is usually entering through the intake system, exhaust system, or head gasket.

If the water is contained to crankcase only, it is usually caused by a cracked or porous block, a flooded bilge, or condensation.

If the water is located in both the cylinder(s) and the crankcase, it is usually caused by water in the cylinders getting past the rings and valves, or complete submersion.

Checking for rust in the intake manifold or exhaust manifolds is a good idea. Rust in these areas will give clues if the water entered these areas.

If water is contained to cylinder(s) only, it is usually entering through the intake system, exhaust system, or head gasket.

Water In Crankcase

Cause	Special Information
1. Water in boat bilge	1. Boat has been submerged or bilge water was high enough to run in through dipstick tube
2. Water seeping past piston rings or valves	2. Refer to "Water in Engine" ("On Top of Pistons")
3. Engine running cold	3. Defective thermostat, missing thermostat; prolonged idling in cold water
4. Intake manifold leaking near a water passage	
5. Cracked or porous casting	5. Check cylinder head, cylinder block, and intake manifold

Water On Top Of Pistons

Cause	Special Information
1. Operator shut engine off at high RPM	
2. Engine “diesels” or tries to run backwards	2. Engine out of tune, poor fuel, high idle RPM, timing set too high
3. Rain water running into flame arrestor	3. Hatch cover
4. Spark plug misfiring	4. Improper combustion causes moisture in the air to accumulate in the cylinder
5. Backwash through the exhaust system	
6. Improper engine or exhaust hose installation	
7. Cracked exhaust manifold	
8. Improper manifold to elbow gasket installation	
9. Loose cylinder head bolts	
10. Blown cylinder head gasket	10. Check for warped cylinder head or cylinder block
11. Cracked valve seat	
12. Porous or cracked casting	12. Check cylinder heads, cylinder block, and intake manifold

Engine Overheats (Mechanical)

Cause	Special Information
1. Engine RPM below specifications at wide-open-throttle (engine laboring)	1. Damaged or wrong propeller; growth on boat bottom;false bottom full of water
2. Wrong ignition timing	2. Timing too far advanced or retarded
3. Sticking distributor advance weights	
4. Spark plug wires crossed (wrong firing order)	
5. Lean fuel mixture	5. Refer to “Carburetor Malfunctions” in this section
6. Wrong heat range spark plugs	
7. Exhaust restriction	
8. Valve timing off	8. Jumped timing chain, or improperly installed
9. Blown head gasket(s)	9. A blown head gasket(s) normally cannot be detected by a compression check. Normally the engine will run at normal temperature at low RPM, but will overheat at speeds above 3000 RPM. **Engines that are seawater cooled**: Using a clear plastic hose, look for air bubbles between seawater pump and engine. If there are no bubbles present, install clear plastic hose be tween thermostat housing and manifold(s).If air bubbles are present at a higher RPM, it is a good indication there is a blown head gasket.
10. Insufficient lubrication to moving parts of engine	10. Defective oil pump, plugged oil passage, low oil level

Engine Overheats (Cooling System)

Cause	Special Information
IMPORTANT: The first step is to verify if the engine is actually overheating or the temperature gauge or sender is faulty	**IMPORTANT: Best way to test gauge or sender is to replace them.**
1. Loose or broken drive belt	
2. Seawater shutoff valve partially or fully closed (if equipped)	
3. Clogged or improperly installed sea strainer	
4. Loose hose connections between seawater pickup and seawater pump inlet (models with belt driven seawater pump only)	4. Pump will suck air. Pump may fail to prime or will force air bubbles into cooling system.
5. Seawater inlet hose kinked or collapsed	
6. Seawater pickup clogged	
7. Obstruction on boat bottom causing water turbulence	7. Obstruction will be in front of seawater pickup, causing air bubbles to be forced into cooling system
8. Defective thermostat	
9. Exhaust elbow water outlet holes plugged	
10. Insufficient seawater pump operation	10. Worn pump impeller
11. Obstruction in cooling system such as casting flash, sand, rust, salt, etc.	11. Refer to water flow diagram for engine type being serviced
12. Engine circulating pump defective	
13. Also refer to “Engine Overheats (Mechanical)”	
IMPORTANT: In addition to previous checks, make the following checks if engine is equipped with closed cooling.	
14. Low coolant level	

Engine Overheats (Cooling System) (Continued)

15. Antifreeze not mixed properly	15. Antifreeze should be mixed 50/50 or maximum 60/40 (60% antifreeze, 40% water)
16. Heat exchanger cores plugged	
17. Water hoses reversed at the water distribution block	17. Refer to water flow diagram in SECTION 6

Poor, Erratic, or No Assist

Cause	Special Information
1. Drive belt	1. Worn, broken or out of adjustment
2. Low fluid level	
3. Air in system	3. Air leak in lines, pump, or air from installation. Refer to SECTION 9A for bleeding procedure.
4. Leaking hoses	4. Refer to SECTION 10A for bleeding procedure.
5. Steering cables and/or steering helm	5. Cable or helm partially frozen from rust or corrosion; cable over-lubricated; improper cable installation
6. Binding in stern drive unit	6. Refer to appropriate Stern Drive Service Manual
7. Restriction in hydraulic hoses	7. Causes a loss of pressure
8. Control valve not positioned properly, not balanced properly, or the mounting nut is loose	
9. Mounting bracket adjusting screw loose or mounting tube is loose	
10. Faulty pump	10. Flow control valve may be sticking
11. Worn piston ring or scored housing bore in cylinder	11. Causes loss of pressure
12. Leaking valve body or loose fitting spool	

Noisy Pump

Cause	Special Information
1 Drive belt	1. Check belt tension
2. Low fluid level	
3. Air in fluid	3. Air leak in lines, pump, or air form installation
4. Faulty pump	4. Use stethoscope to listen for noise in pump
5. Restricted fluid passages	5. Kinks or debris in hoses or debris in passages
6. Stop nut adjusted improperly	6. Refer to appropriate Stern Drive Service Manual
7. Steering cables installed that do not meet BIA standards	7. Refer to appropriate Stern Drive Service Manual

Fluid Leaks

Cause	Special Information
1. Loose hose connections	1. Refer to SECTION 10A for bleeding instructions
2. Damaged hose	
3. Oil leaking from top of pump	3. System overfilled; fluid contains water; fluid contains air
4. Cylinder piston rod seal	
5. Faulty seals in valve	
6 Faulty seals in O-rings in pump	
7. Cracked or porous metal parts	

Insufficient Water Flow from Alpha One Stern Drive Unit Seawater Pickup Pump

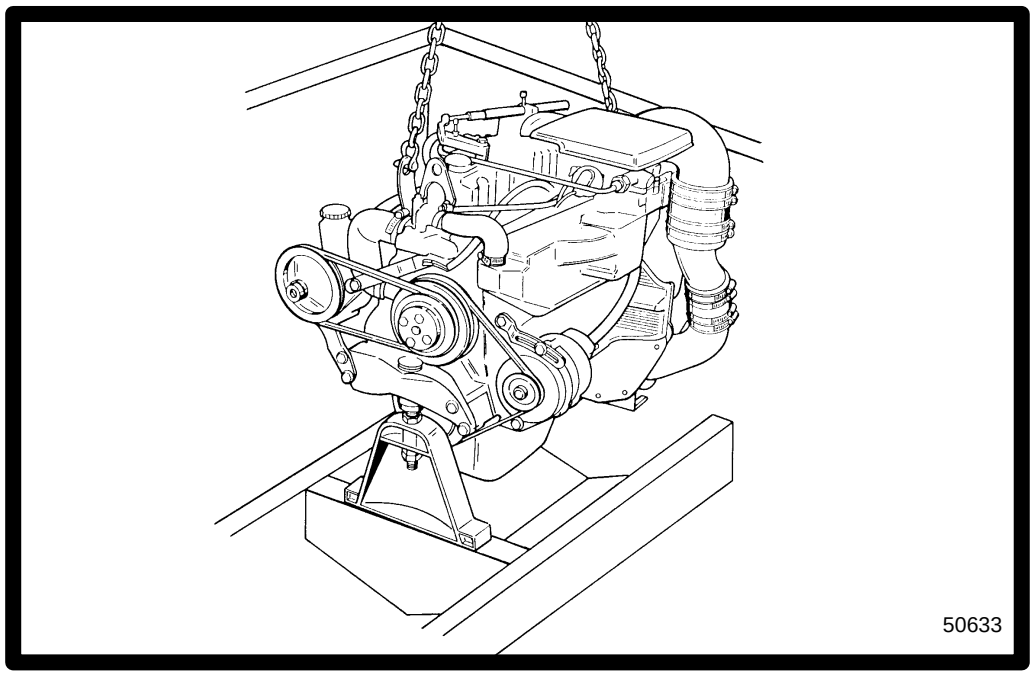
CAUSE	SPECIAL INFORMATION
1 Seawater shutoff valve partially or fully closed (if equipped)	
2. Water pick up clogged with foreign material	
3. Kinked or broken bell housing to gimbal housing water tube hose	
4. Corroded through gimbal housing water tube	
5. Water pick up inserts warped. (Engine will over heat while boat is underway.)	5. Pick up must not protrude above gear housing surface or inserts will create an irregular or turbulent water flow over the water pick up holes. Consequently, this may cause loss of cooling water and subsequent engine overheating. This condition can be identified by cavitation burn (pitting or erosion) the gear housing in the area aft of the water pick up.
6. Damaged gear housing or accessories improperly installed on boat bottom or transom (speedometer pick up, depth sounder transducer, etc) Substan tial amount of barnacles or other marine growth on gear housing or boat bottom. (Engine will over heat while underway only)	6. An object or an irregularity on boat or gear hous ing in area close to to water pick ups could create turbulence in water flow going to water pickups. This could aerate the water flow and cause en gine to overheat
7. Stern drive installed too high on transom or drive unit trimmed out too far out allowing air to be drawn into pump. (Engine will overheat while un derway only)	7. Contact boat company if stern drive is too high. Instruct operator on proper trimming technique if until is trimmed out too far.
8. Bell housing -to-driveshaft housing O-ring missing or damaged	
9. Faulty seawater pick up pump	
10. Seawater pick up tube corroded thru	
11. Driveshaft housing water pocket cover cracked	
12. Broken-off impeller blade or other obstruction in water passages (usually lodges in driveshaft housing water pocket cover or cross drilled water passage).	12. To check cross drilled water passages in drive shaft housing, remove plug and pipe plug located under decal on starboard side of housing. Drive unit must be shifted into reverse to remove pipe plug.
13. Water passage in driveshaft housing improperly drilled	

Index

REMOVAL AND INSTALLATION

2

A



4 CYL – ALPHA ONE DRIVE

Index

Table of Contents

	Page
Torque Specifications	2A-1
Tools/Lubricants/Adhesives/Sealants	2A-1
Removal	2A-2
Engine Removal	2A-2
Installation	2A-5
Engine Installation/Alignment	2A-5
Engine Connections	2A-8

NOTICE

For information and procedures on troubleshooting refer to SECTION 1C.

Torque Specifications

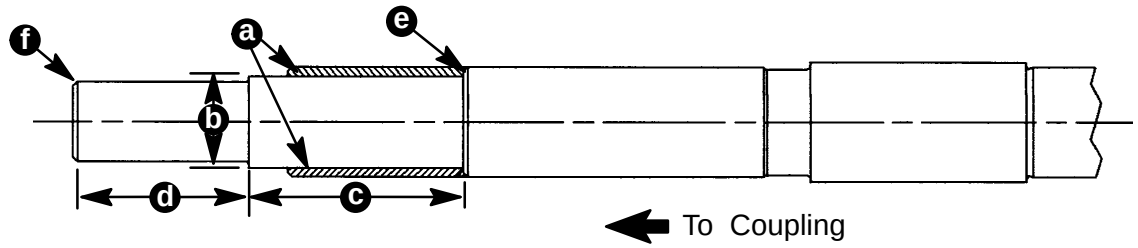
DESCRIPTION	Lb. In.	Lb. Ft.	N·m
Power Steering Hydraulic Hose Fittings		20-25	27-34
Front Engine Mounts		30-40	42-54
Rear Engine Mounts		35-40	47-54
Drive Unit Shift Cables (Cable End and Cable End Guide)	Tighten Until Bottoms Out, Then Back Off 1/2 Turn Spread Cotter Keys		
Remote Control Shift Cables	Tighten Securely		
Remote Control Throttle Cables			
Hose Clamps			
Battery Cables			

Tools/Lubricants/Adhesives/ Sealants

Description	Part Number
Quicksilver Engine Coupler Spline Grease	92-816391A4
Quicksilver 2-4-C Marine Lubricant With Teflon	92-825407A3
Quicksilver Liquid Neoprene	92-25711-2
Engine Alignment Tool	91-57797A3 91-805475A-1
Loctite Pipe Sealant with Teflon	Obtain Locally

CAUTION ⚠

DO NOT use an alignment tool from another manufacturer. Alignment tools other than Quicksilver Alignment Tools (91-805475A1 or a properly modified 91-57797A3) may cause improper alignment and damage to gimbal bearing and/or engine coupler Quicksilver Engine Alignment Tool (91-57797A3) Modification.



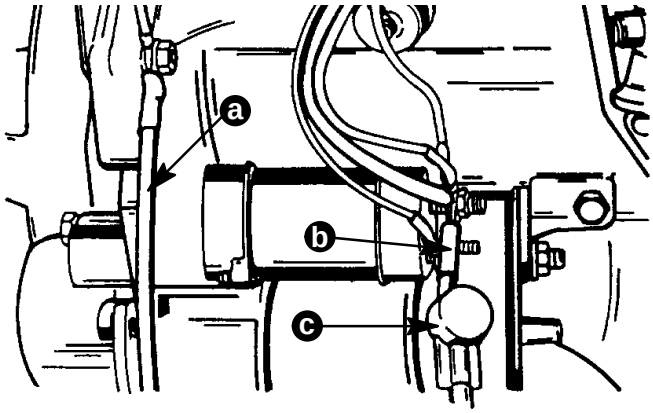
a - Material To Be Removed (Shaded Area)
b - Measurement - 1.150 in. (29.21 mm)
c - Measurement - 2.750 in. (69.85 mm)
d - Measurement - 2.200 in. (55.88 mm)
e - Radius - .060 (1.5 mm)
f - Chamfer - .060 in. (1.5 mm) x 45 degree

Removal

IMPORTANT: Stern drive unit must be removed prior to engine removal. Refer to Stern Drive Service Manual.

Engine Removal

1. Disconnect battery cables from battery.



22052

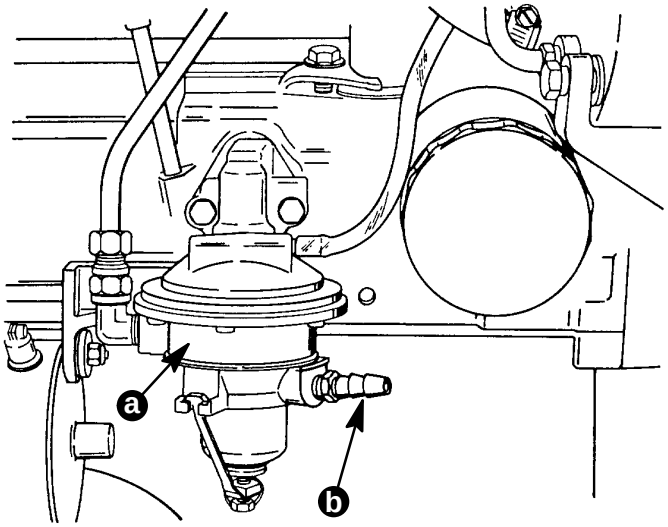
a - Negative (-) Battery Cable
b - Positive (+) Battery Cable
c - Rubber Boot (Slid Back From Terminal)

2. Remove instrument harness connector plug from engine harness receptacle after loosening clamp.

⚠WARNING

Be careful when working on fuel system. Gasoline is extremely flammable and highly explosive under certain conditions. Do not smoke or allow spark or open flame in area. Wipe up any spilled fuel immediately.

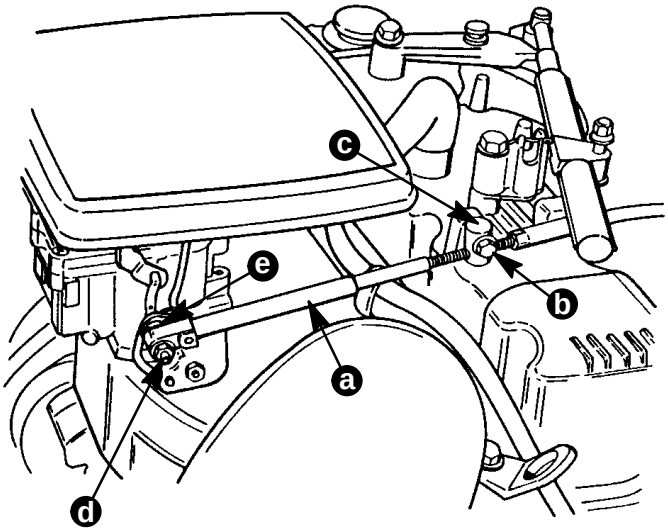
3. Disconnect and plug fuel line to prevent fuel in tank from leaking into bilge.



50738

a - Fuel Pump
b - Disconnect Fuel Inlet Line Here - Plug inlet hose

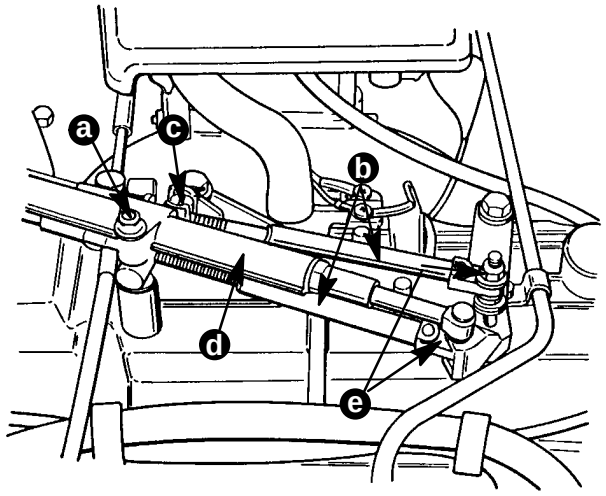
4. Disconnect throttle cable from carburetor and retain locknuts and hardware.



50626

a - Cable End Guide
b - Throttle Cable Anchor Screw
c - Cable Barrel
d - Elastic Stop Nut and Flat Washer
e - Throttle Lever

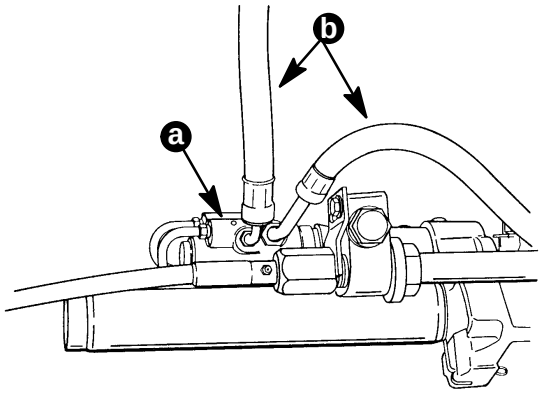
5. Disconnect shift cables and shift assist assembly (if equipped).



50626

a - Locking Nut
b – Shift Cable End
c - Cotter Pin
d - Shift Assist Assembly
e - Clevis Pin (w/Cotter Pin)

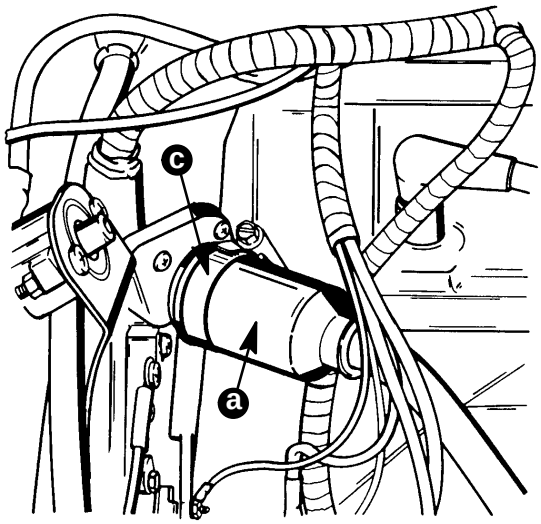
6. Disconnect and cap power steering hoses, plug control valve hose connection holes.



50628

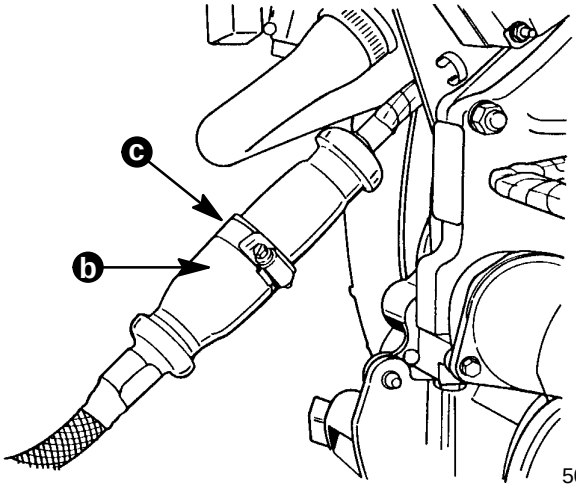
a - Power Steering Control Valve
b - Power Steering Hoses

7. Loosen clamp and unplug wiring harness



50113

Breaker Point Ignition



50626

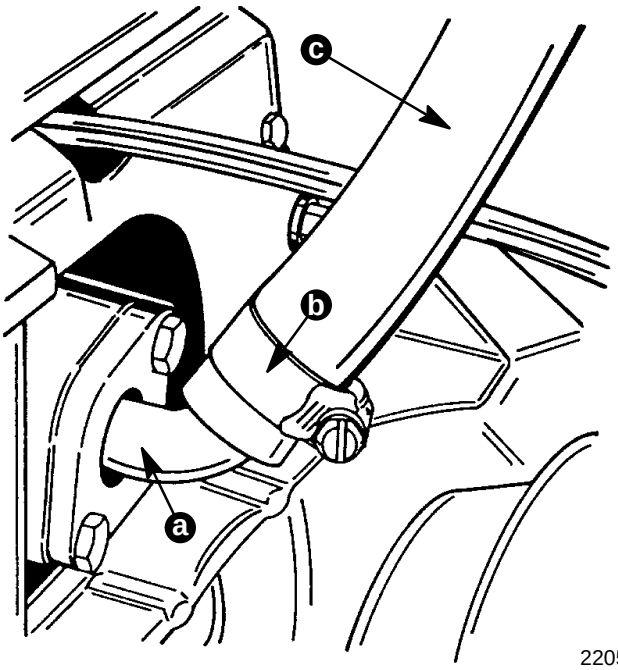
DDIS And EST Ignition Models

a - Engine Wiring Harness Receptacle (Bracket)
b - Instrumentation Wiring Harness
c - Hose Clamp

8. Disconnect bullet connectors of trim sender wires (coming from transom assembly) from engine harness.

NOTE: After wires are disconnected be sure to loosen them from clamps or Sta-Straps retaining them to engine or hoses.

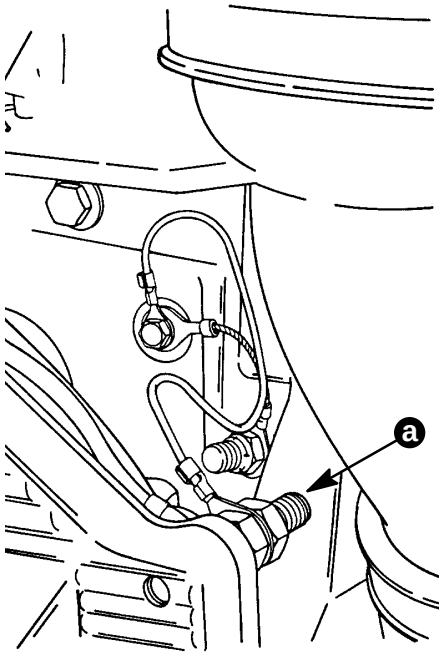
9. Slide sleeves back on BLACK and WHITE/GREEN (or GRAY) wires and disconnect engine harness wires from shift cut-out switch harness.
10. Disconnect MerCathode wires from MerCathode controller if so equipped.
11. Disconnect seawater inlet hose from gimbal housing.



22055

a - Water Tube
b - Hose Clamp (Tighten Securely)
c - Water Hose

12. Loosen hose clamps and disconnect exhaust elbow hose.
13. Remove both shift cables from shift plate. Retain locknuts and hardware.
14. Disconnect any grounding wires and accessories that are connected to engine.



50636

a - Ground Stud

15. Disconnect (and suitably plug) fluid hoses from power steering control valve on transom.

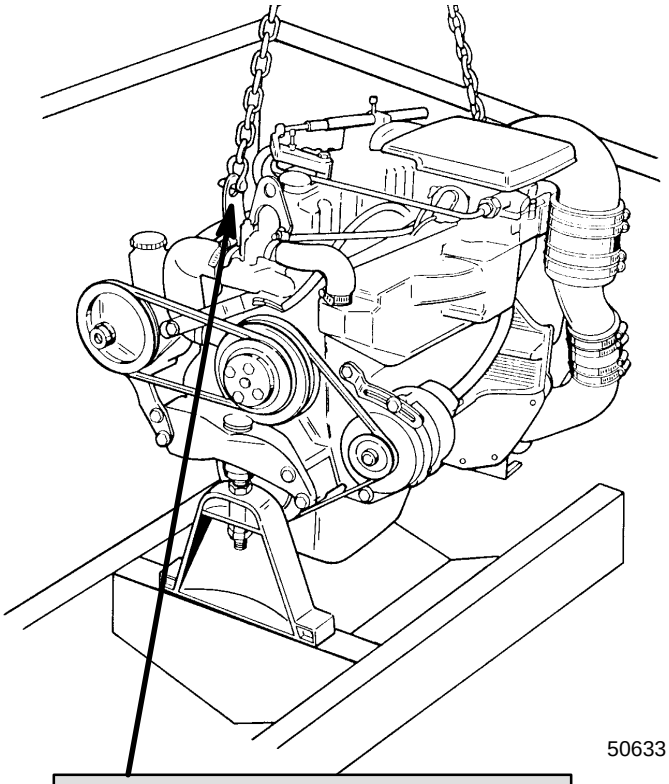
CAUTION

Center lifting eye (located on top of thermostat housing) is used for engine alignment only. DO NOT use to lift entire engine.

CAUTION

DO NOT allow lifting sling to hook or compress engine components or damage will occur.

16. Support engine with suitable sling through lifting eyes on engine and remove front and rear engine mounting bolts. Retain hardware.



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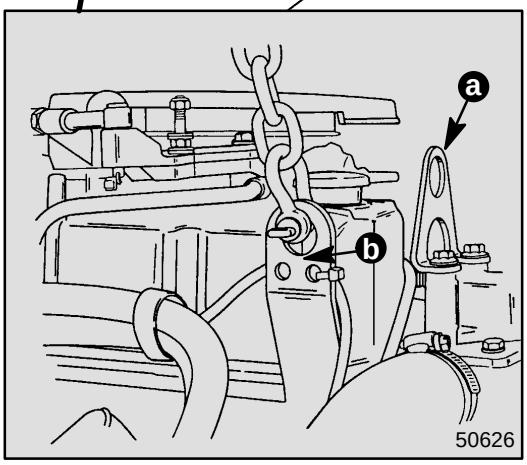


50626

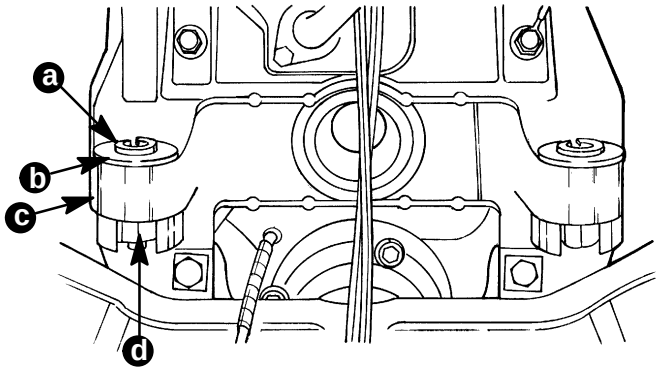
a - Center Lifting Eye - DO NOT use to lift engine
b - Use This Lifting Eye

17. Carefully remove engine. DO NOT hit power steering control valve.

Installation

Engine Installation/Alignment

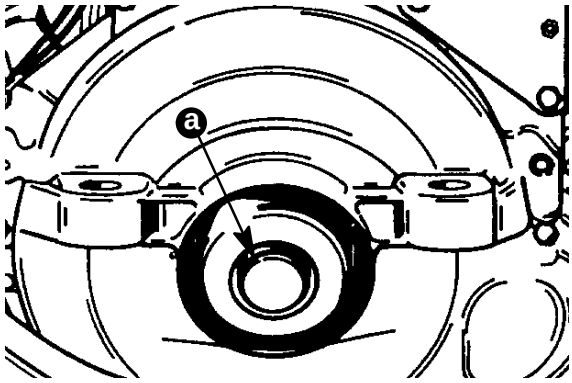
1. Follow instructions “a”-“e”:
   a. Be certain fiber washers (cemented in place) on inner transom plate are present. Inspect fiber washers. Replace if worn or damaged.
   b. Install double wound lockwashers onto inner transom plate inside fiber washer.



72023

a - Double Wound Lockwasher
b - Fiber Washer (Cemented in Place)
c - Inner Transom Plate Mount (Engine Support)
d - Locknuts (Engine Mounting Bolts)

   c. Be certain rear engine mount locknuts are in position as shown.
   d. Lubricate exhaust bellows with soap and water to ease installation.
   e. Lubricate engine coupling splines with Quicksilver Engine Coupler Spline Grease.



22054

a - Lubricate Splines with Quicksilver Engine Coupler Grease 92-816391A4

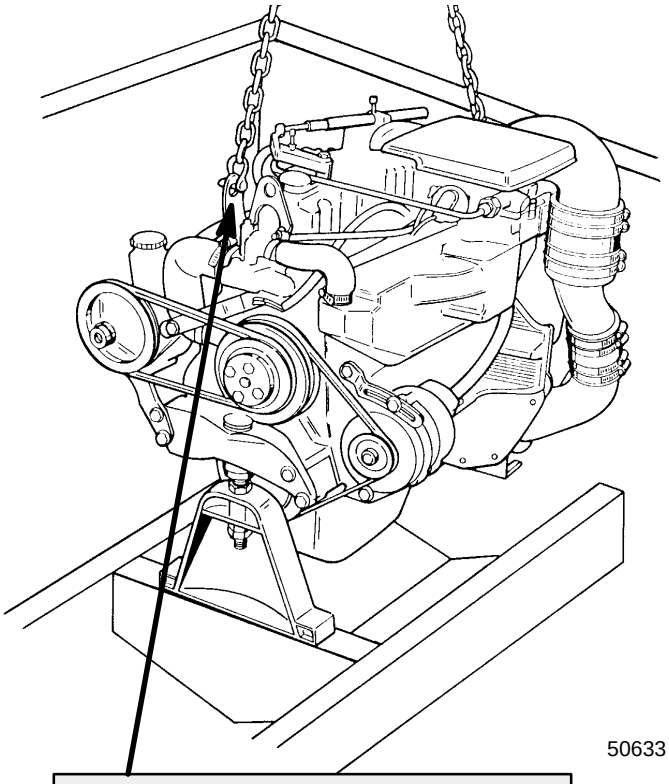
CAUTION ⚠

Center lifting eye (located on top of thermostat housing) is used for engine alignment only. DO NOT use to lift entire engine.

CAUTION ⚠

DO NOT allow lifting sling to hook or compress engine components or damage will occur.

2. Attach a suitable sling to lifting eyes on engine and adjust so that engine is level when suspended.
3. Lift engine into position (in boat), using an overhead hoist.



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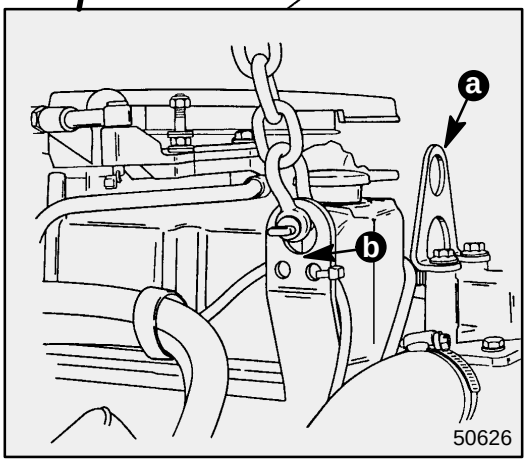
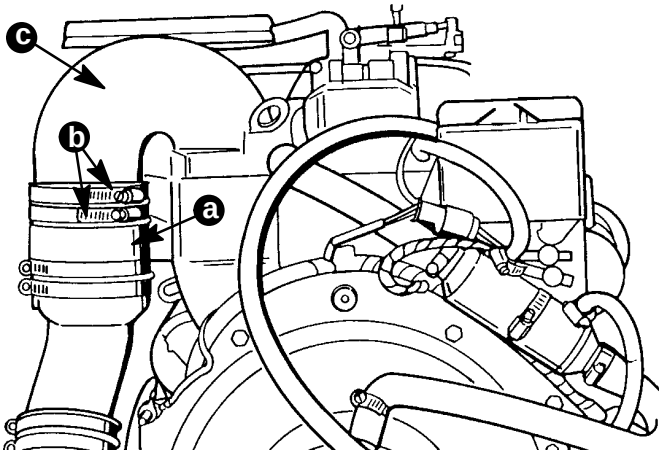


50626

a - Center Lifting Eye - DO NOT use to lift engine
b - Use This Lifting Eye

4. Align rear engine mounts with inner transom plate mounts while simultaneously aligning exhaust tubes with exhaust pipe hoses (bellows).

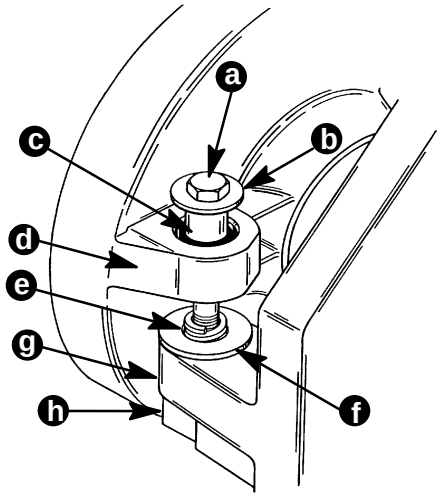


50629

a - Bellows
b - Clamps
c - Exhaust Pipe

IMPORTANT: Engine attaching hardware must be installed in sequence shown.

5. Install both rear engine mounting bolts and hardware as shown. Torque to 35-40 lb. ft. (47-54 N·m).



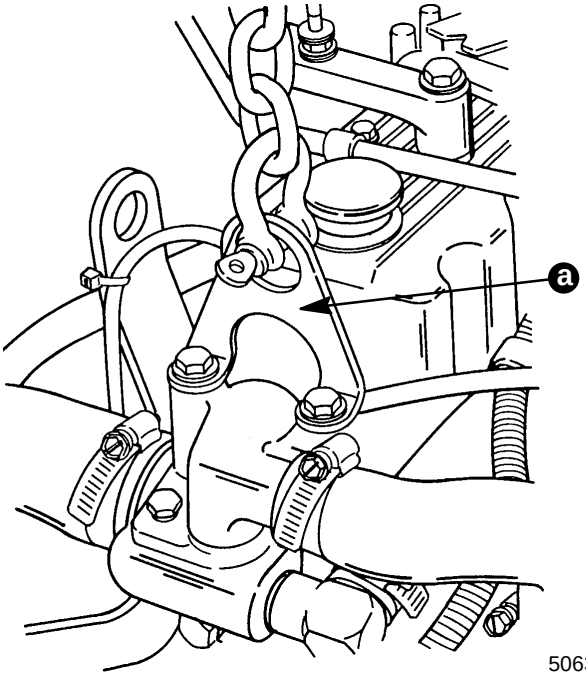
72535

a - Bolt, Rear Engine Mounting
b - Washer, Large Steel
c - Spacer, Metal
d - Rear Engine Mount
e - Double Wound Lockwasher
f - Fiber Washer
g - Inner Transom Plate Mounts
h - Locknut (Hidden in This View)

CAUTION ⚠

When lowering engine into position DO NOT set engine on shift cable. Shift cable outer casing can be crushed causing difficult or improper shifting.

6. Set engine down on stringers and relieve hoist tension. Disconnect sling from engine lifting eyes and switch sling to center lifting eye.



a - Center Lifting Eye

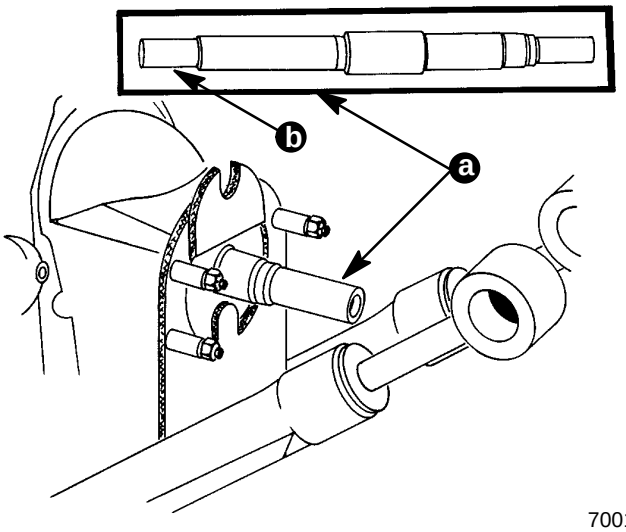
IMPORTANT: The modified 91-57797A3 tool or the new tool 91-805475A1 will align all current Alpha One as well as all older engines that used the older 91-57797A3.

CAUTION ⚠

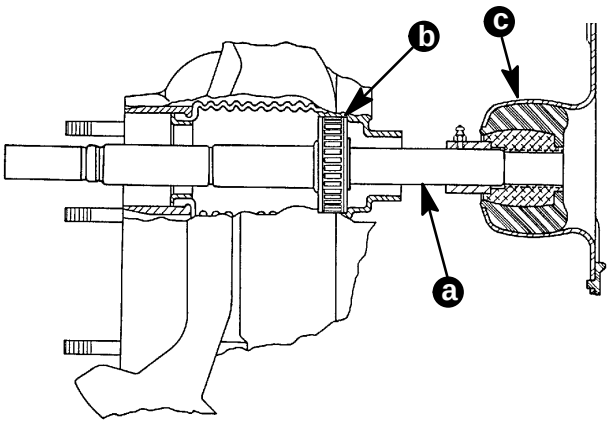
To avoid damage to gimbal bearing, engine coupler, or alignment tool:

- **DO NOT attempt to force alignment tool!**
- **DO NOT raise or lower engine with alignment tool inserted (or partially inserted) in gimbal bearing or engine coupler.**

7. Align engine as follows:
   a. Attempt to insert solid end of Quicksilver Alignment Tool through gimbal bearing and into engine coupler splines. If it will not insert easily proceed to following.
   b. While observing the above precautions, CAREFULLY raise and lower front of engine with hoist, as required, until tool will SLIDE FREELY all the way in and out of engine coupler splines.



a - Alignment Tool (Use Only Quicksilver Alignment Tool 91-805475A1, or Properly Modified 91-57797A3)
b - Insert This End of Alignment Tool through Gimbal Housing Assembly

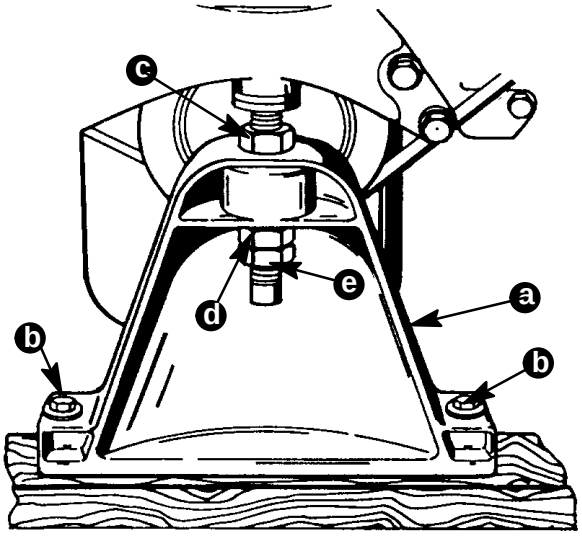


a - Alignment Tool
b - Gimbal Bearing
c - Engine Coupler

IMPORTANT: Turn both front engine mount adjustment nuts an equal amount in direction required to align engine.

   c. Adjust front engine mounts until they rest on boat stringers.
   d. Relieve hoist tension entirely and fasten both front mounts to boat stringer using appropriate hardware (lag bolts or thru-bolts, etc).
   e. Recheck alignment with alignment tool. Tool must enter coupler splines freely. If not, readjust front mounts.

f. When alignment is correct, tighten locknut or nut with lockwasher on each mount securely.

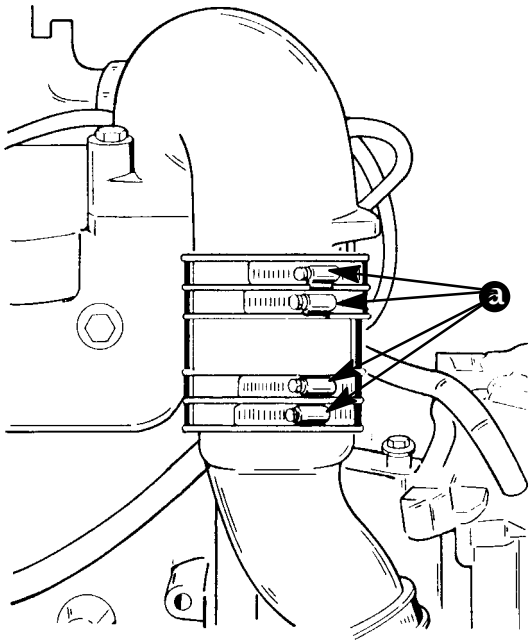


22054

a - Front Mount
b - Attaching Bolts and Flat Washers
c - Adjustment Nut
d - Locknut
e - Jam Nut

g. Remove alignment tool if not already removed.

8. Tighten all exhaust system hose clamps securely as follows (use two hose clamps on each connection):



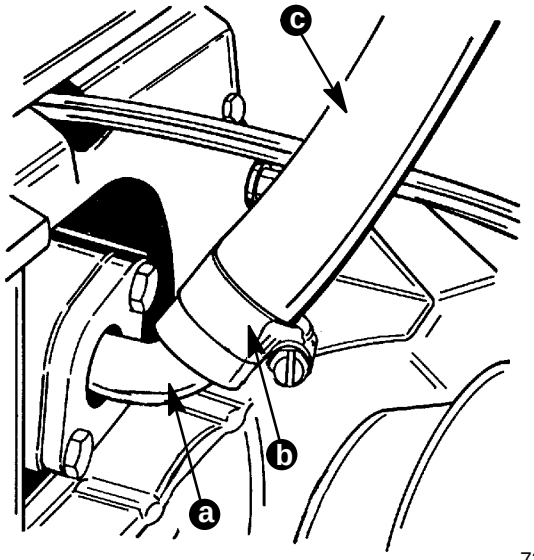
50633

a - Hose Clamps

Engine Connections

IMPORTANT: When routing all wire harnesses and hoses, be sure they are routed and secured to avoid coming in contact with hot spots on engine and avoid contact with moving parts.

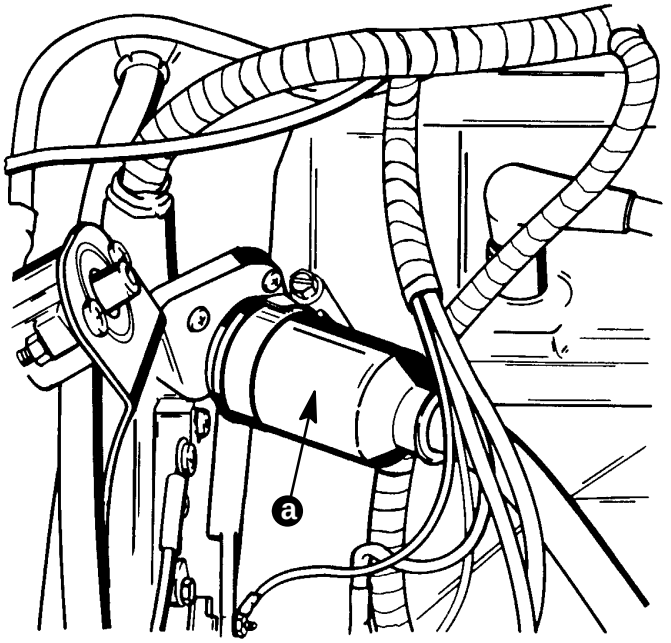
1. Connect seawater hose to water tube at gimbal housing with hose clamp. Tighten clamp securely.



72614

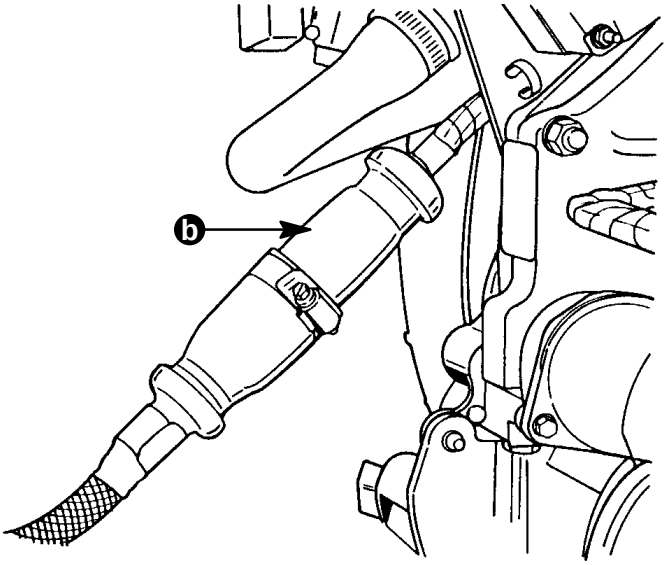
a - Water Inlet Tube
b - Hose Clamp
c - Seawater Inlet

2. Connect instrument harness to engine harness with hose clamp. Tighten clamp securely.



50113

Breaker Points Ignition Wiring Harness

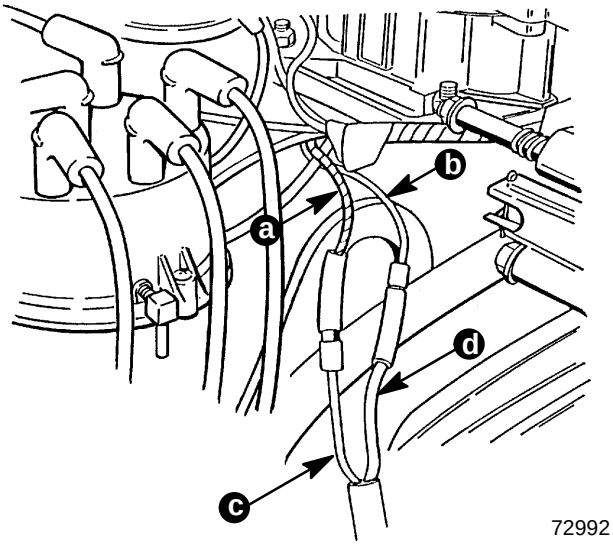


50626

DDIS Engine Wiring Harness

a - Engine Wiring Harness - Tighten Clamp Securely
b - DDIS Engine Wiring Harness - Tighten Clamp Securely

3. Connect trim position sender leads from gimbal housing to leads from engine harness.



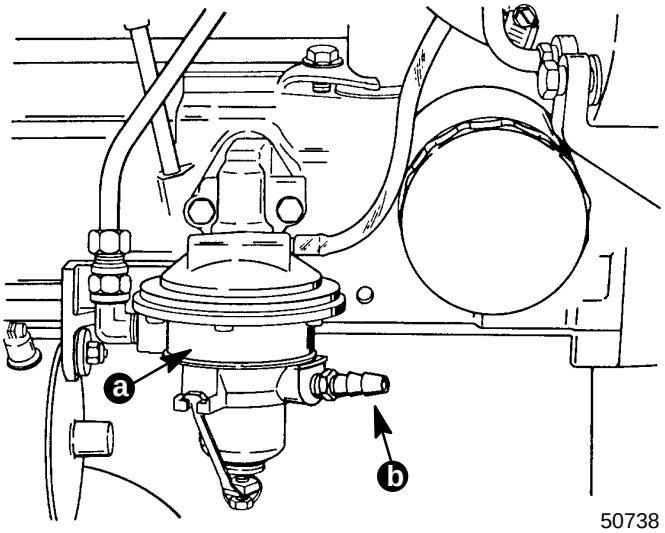
72992

a - Brown/White (From Engine Harness)
b - Black (From Engine Harness)
c - Black (From Transom Assembly)
d - Black (From Transom Assembly)

⚠ WARNING

Be careful when working on fuel system. Gasoline is extremely flammable and highly explosive under certain conditions. Do not smoke or allow spark or open flame in area. Wipe up any spilled fuel immediately.

4. Connect fuel line from fuel tank(s) to engine. Make certain connections are secure. Check for leaks.



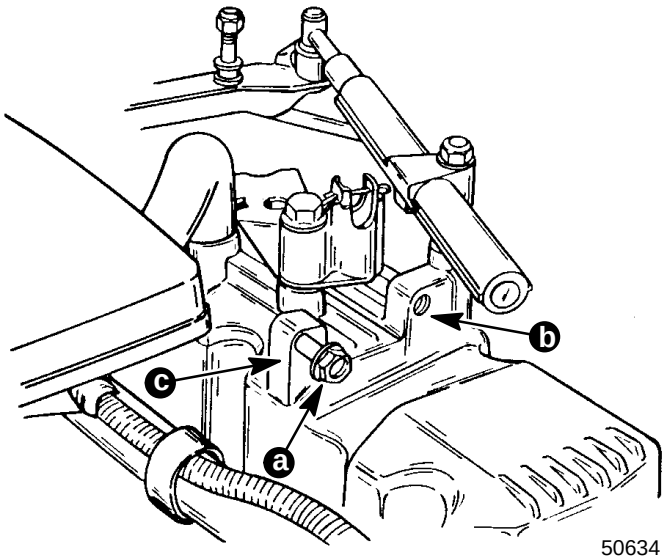
50738

a - Fuel Pump
b - Connect Flexible Fuel Inlet Line Here

5. Connect throttle cable using hardware retained and adjust as follows:

   a. Place remote control handle(s) in neutral, idle position.

IMPORTANT: Be sure that cable is routed in such a way as to avoid sharp bends and/or contact with moving parts. DO NOT fasten any items to throttle cable. Outer cable must be free to move when cable is actuated.

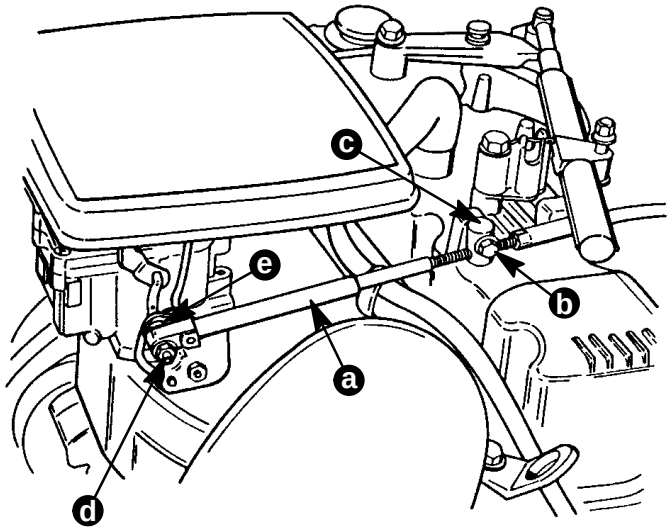


50634

a - Anchor Bolt
b - Use This Boss - 3.0L
c - Use This Boss - 3.0LX

   b. Install cable end guide on throttle lever, then push cable barrel lightly toward throttle lever end. (This will place a slight preload on cable to avoid slack in cable when moving remote control lever.) Adjust barrel on throttle cable to align with anchor stud.

   c. Secure throttle cable with hardware (retained) as shown. Tighten cable end guide locknut until it bottoms out and then back off one full turn. Tighten cable barrel securely. DO NOT OVER-TIGHTEN, as cable must pivot freely.

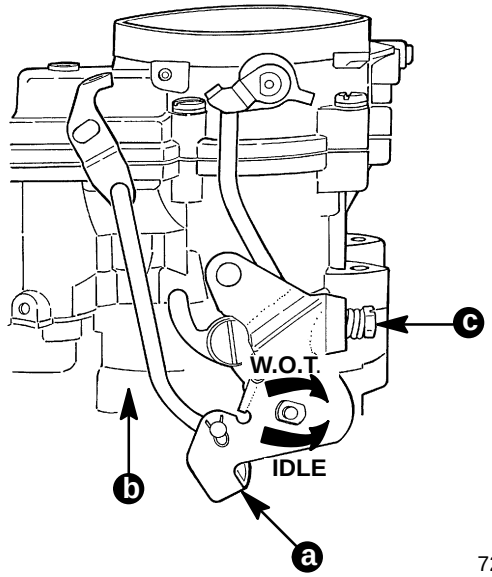


50626

a - Cable End Guide
b - Throttle Cable Anchor Screw
c - Cable Barrel
d - Elastic Stop Nut and Flat Washer
e - Throttle Lever

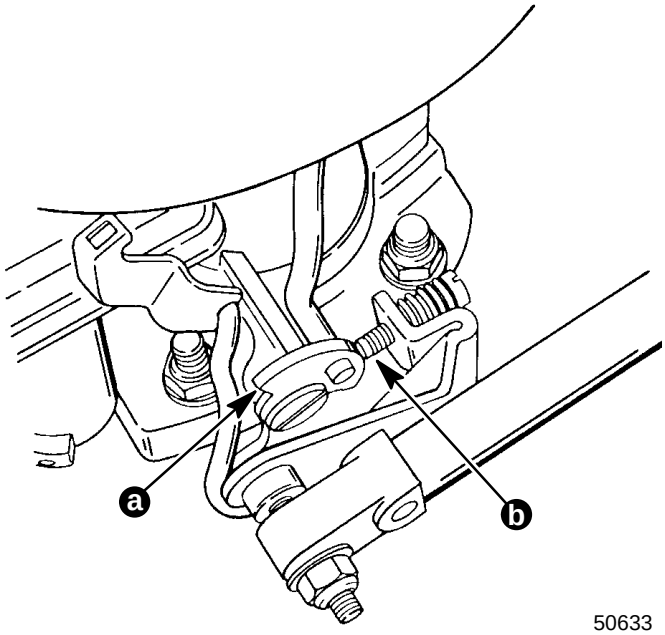
   d. Place remote control throttle lever in the wide-open-throttle (W.O.T.) position. Check to ensure that throttle shutters (valves) are completely open and throttle shaft lever contacts carburetor body casting.

e. Return remote control throttle lever to idle position and check to ensure that throttle lever contacts idle speed adjustment screw.



72283

a - Throttle Lever Tang
b - Carburetor Body
c - Idle RPM Adjustment Screw



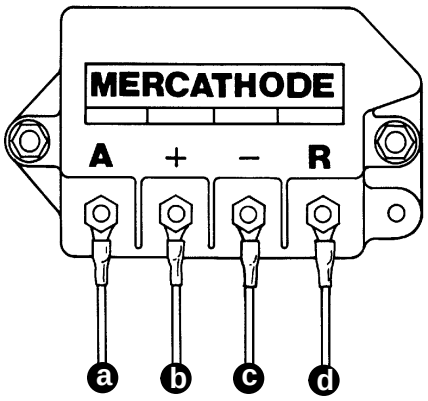
50633

a - Throttle Lever
b - Idle Speed Adjustment Screw

IMPORTANT: Do not attach any accessory ground (–) wires to transom plate ground point. Accessory ground wires should only be attached to ground stud on engine.

6. Connect any grounding wires or accessories that may have been disconnected.

7. Connect MerCathode wires to MerCathode controller assembly as shown, if so equipped. Apply a thin coat of Quicksilver Liquid Neoprene to all connections.



22232

a - ORANGE Wire - From Electrode on Transom Assembly
b - RED/PURPLE Wire - Connect (Other End) to Positive (+) Battery Terminal
c - BLACK Wire - From Engine Harness
d - BROWN Wire - From Electrode on Transom Assembly

IMPORTANT: Adjust shift cables as outlined in appropriate Stern Drive Service Manual.

8. Refer to appropriate Stern Drive Service Manual and install and adjust drive unit and remote control shift cables, using hardware retained.

IMPORTANT: After fluid hose installation in the following, bleed power steering system as outlined in SECTION 1B - "Maintenance" or refer to appropriate Stern Drive Service Manual.

9. Connect power steering fluid hoses to control valve (large fitting first) as shown.

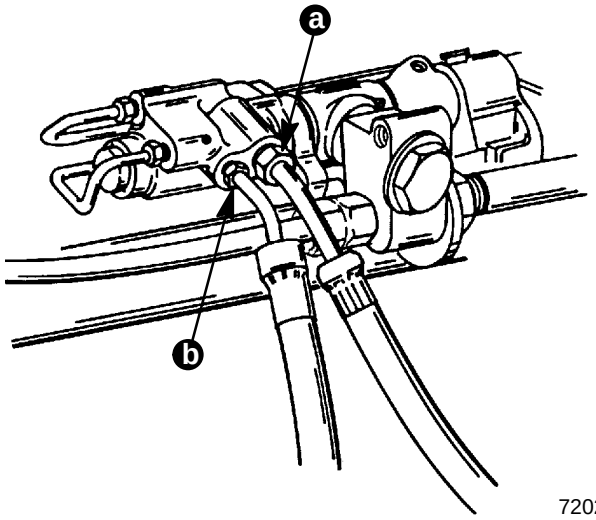
CAUTION ⚠

Route hoses exactly as shown below. This will help avoid stress on the hose fittings and will help avoid kinks in the hose.

IMPORTANT: Make hydraulic connections as quickly as possible to prevent fluid leakage.

IMPORTANT: Be careful not to cross-thread or over tighten fittings.

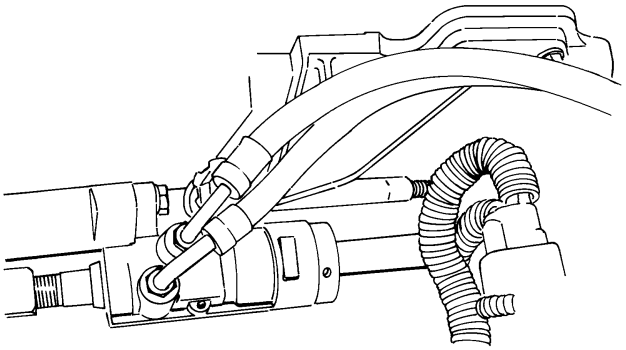
Earlier Style Control Valve: Torque large fitting to 20-25 lb. ft. (27-34 N·m) and small fitting to 96-108 lb. in. (11-12 N·m).



72026

a - Large Fitting
b - Small Fitting

Later Style Control Valve: Torque fittings to 23 lb. ft. (31 N·m).



73786

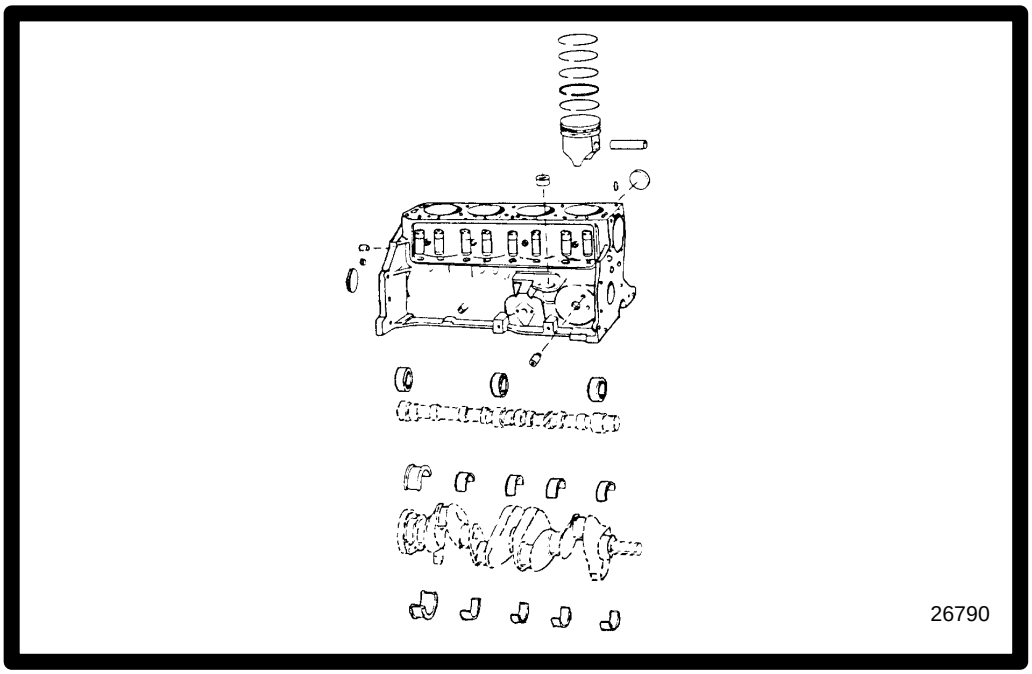
10. Connect battery cables to battery by FIRST connecting POSITIVE (+) battery cable (usually RED) to POSITIVE (+) battery terminal. Tighten clamp securely. Then, connect NEGATIVE (–) battery cable (usually BLACK) to NEGATIVE (–) battery terminal. Tighten clamp securely.

NOTE: Spray terminals with a battery connection sealant to help retard corrosion.

ENGINE

3

A



181 CID (3.0L) 4 CYLINDER GM ENGINE

Index

Table of Contents

Page

Torque Specifications . . . . . 3A - 1
Tools/Lubricants/Sealants . . . . . 3A - 2
Engine Specifications . . . . . 3A - 3
Cylinder Bore . . . . . 3A - 3
Piston Clearance . . . . . 3A - 3
Piston Ring: Compression . . . . . 3A - 3
Piston Ring: Oil . . . . . 3A - 3
Piston Pin . . . . . 3A - 3
Crankshaft . . . . . 3A - 4
Camshaft . . . . . 3A - 4
Cylinder Head . . . . . 3A - 4
Valve System . . . . . 3A - 5
General . . . . . 3A - 6
Engine Identification . . . . . 3A - 6
Engine Rotation . . . . . 3A - 6
Firing Order . . . . . 3A - 6
Priming Engine With Oil . . . . . 3A - 7
Tool Required . . . . . 3A - 7
Bearing Failures . . . . . 3A - 8
Piston Failures . . . . . 3A - 8
Pre-Ignition . . . . . 3A - 8
Pre-Ignition Causes . . . . . 3A - 8
Detonation . . . . . 3A - 9
Other Causes of Detonation . . . . . 3A - 9
Engine Mounts . . . . . 3A - 10
Rocker Arm Cover . . . . . 3A - 10
Removal . . . . . 3A - 10
Installation . . . . . 3A - 10
Rocker Arm/Push Rod . . . . . 3A - 11
Removal . . . . . 3A - 11
Cleaning and Inspection . . . . . 3A - 11
Installation . . . . . 3A - 11
Valve Adjustment . . . . . 3A - 12
Engine Not Running . . . . . 3A - 12
Engine Running . . . . . 3A - 12
Hydraulic Valve Lifters . . . . . 3A - 13
Locating Noisy Lifters . . . . . 3A - 13
Removal . . . . . 3A - 13
Cleaning and Inspection . . . . . 3A - 14
Installation . . . . . 3A - 14
Valve Stem Oil Seal/Valve Spring . . . . . 3A - 15
Replacement Oil Seal
Head Installed . . . . . 3A - 15
Cylinder Head . . . . . 3A - 16
Cleaning and Inspection . . . . . 3A - 16
Installation . . . . . 3A - 16
Cylinder Head and Valve Conditioning . . . . 3A - 17
Disassembly . . . . . 3A - 17

Page

Cleaning . . . . . 3A - 17
Inspection . . . . . 3A - 18
Rocker Arm Studs . . . . . 3A - 19
Valve Guide Bore Repair . . . . . 3A - 19
Valve Springs - Checking Tension . . . . . 3A - 19
Valve Seats . . . . . 3A - 20
Reassembly . . . . . 3A - 20
Dipstick Specifications . . . . . 3A - 22
All Engines . . . . . 3A - 22
Oil Pan . . . . . 3A - 22
Removal . . . . . 3A - 22
Installation . . . . . 3A - 22
Oil Pump . . . . . 3A - 23
Removal . . . . . 3A - 23
Disassembly . . . . . 3A - 23
Cleaning and Inspection . . . . . 3A - 23
Reassembly . . . . . 3A - 23
Installation . . . . . 3A - 24
Torsional Damper . . . . . 3A - 24
Removal . . . . . 3A - 24
Installation . . . . . 3A - 24
Crankcase Front Cover/
Oil Seal . . . . . 3A - 25
Oil Seal Replacement
(Without Removing Front Cover) . . . . . 3A - 25
Removal . . . . . 3A - 25
Installation . . . . . 3A - 25
Crankcase Front Cover . . . . . 3A - 26
Removal . . . . . 3A - 26
Cleaning and Inspection . . . . . 3A - 26
Installation . . . . . 3A - 26
Flywheel and Engine Coupler . . . . . 3A - 26
Removal . . . . . 3A - 26
Inspection . . . . . 3A - 27
Installation . . . . . 3A - 27
Rear Main Oil Seal . . . . . 3A - 28
Removal . . . . . 3A - 28
Cleaning and Inspection . . . . . 3A - 28
Installation . . . . . 3A - 28
Cleaning and Inspection . . . . . 3A - 28
Installation . . . . . 3A - 28
Main Bearings . . . . . 3A - 29
Inspection . . . . . 3A - 29
Checking Clearances . . . . . 3A - 29
Main Bearing Replacement . . . . . 3A - 30
Connecting Rod Bearings . . . . . 3A - 30
Inspection and Replacement . . . . . 3A - 31
Connecting Rod/Piston Assembly . . . . . 3A - 32

Page

Removal . . . . . 3A - 32
Disassembly . . . . . 3A - 33
Cleaning and Inspection . . . . . 3A - 33
Connecting Rods . . . . . 3A - 33
Pistons . . . . . 3A - 33
Piston Pins . . . . . 3A - 34
Reassembly . . . . . 3A - 34
Pistons and Piston Pins . . . . . 3A - 34
Piston Rings . . . . . 3A - 35
Installation . . . . . 3A - 36
Crankshaft . . . . . 3A - 37
Removal . . . . . 3A - 37
Cleaning and Inspection . . . . . 3A - 37
Installation . . . . . 3A - 37
Crankshaft Sprocket . . . . . 3A - 38
Removal . . . . . 3A - 38
Installation . . . . . 3A - 38

Page

Camshaft . . . . . 3A - 38
Measuring Lobe Lift . . . . . 3A - 38
Removal . . . . . 3A - 39
Inspection . . . . . 3A - 39
Camshaft Gear Replacement . . . . . 3A - 40
Installation . . . . . 3A - 41
Camshaft Bearings . . . . . 3A - 42
Removal . . . . . 3A - 42
Inspection . . . . . 3A - 42
Installation . . . . . 3A - 42
Cylinder Block . . . . . 3A - 44
Cleaning and Inspection . . . . . 3A - 44
Cylinder Conditioning . . . . . 3A - 45
Cylinder Boring . . . . . 3A - 45
Cylinder Honing . . . . . 3A - 45
Piston Selection . . . . . 3A - 46
Oil Filter By-Pass Valve . . . . . 3A - 46
Inspection and/or Replacement . . . . . 3A - 46

Torque Specifications

Fastener Location	Lb. In.	Lb. Ft.	N·m
Camshaft Sprocket Bolts	80		9
Connecting Rod Cap Nuts		45	61
Cylinder Head Bolts		90 Note 1	122
Distributor Clamp		20	27
Engine Coupler to Flywheel		35	47
Flywheel Housing to Block		21	28
Flywheel to Crankshaft Bolts		65	88
Front Cover Bolts	30		3.4
Front Mount to Block		21	28
Main Bearing Cap Bolts		65	88
Manifold to Head		23 Note 2	31
Oil Pan Bolts-Crankcase	80		9
Oil Pan Bolts -to Front Cover	45		5
Oil Pan Studs to Oil Seal Retainer or Crankcase	15		1.7
Oil Pump Cover	72		8
Oil Pump to Block	120		14
Oil Pump Pickup	60		7
Rocker Arm Cover and Bolts	40		4.5
Rear Crankshaft Oil Seal Retainer Nuts	135		15
Spark Plugs		22	30
Starter Motor to Block		37	50
Timing Gear Cover	72		8
Torsional Damper Bolt		50	68
Water Pump to Block		15	20

Note 1: Retorque after first 20 hours of operation.
Note 2: Retorque after first start up.

Tools/Lubricants/Sealants

MERCURY MARINE SPECIAL TOOLS	
91-24697	Piston Ring Expander
91-63209	Torch Lamp

KENT MOORE SPECIAL TOOLS	
J5892	Valve Spring Compressor (Head on)
J8062	Valve Spring Compressor (Head off)
J23738-A	Valve Stem Seal Tester
J8101	Valve Guide Cleaner
J8814	Valve Guide Reamer (Standard)
J5830-02	Valve Guide Reamer (.015 in. oversize)
J5802-01	Rocker Arm Stud Remover
J6880	Rocker Arm Stud Installer
J5715	Stud Bore Reamer (.003 in. oversize)
J6036	Stud Bore Reamer (.013 in. oversize)
J8089	Carbon Remover Brush
J5910-04	Piston Support Tool
J24086-B	Piston Pin Tool
J3936-03	Piston Ring Groove Cleaner
J8037	Piston Ring Compressor
J5239	Connecting Rod Guide Tool (3/8 -24)
J8087	Cylinder Bore Checker
J8369	Oil Pump Suction Pipe Installer
J23042-B	Timing Cover Seal Aligner
J8520	Cam Lobe Lift Indicator
J6098-01	Camshaft Bearing Installer/Remover Tool
J9534-01	Distributor Shaft Lower Bearing Installer/Remover
J6978-E	Pulley Hub Puller
J5590	Pulley Hub Installer
J24420-B	Universal Torsional Damper Remover

LUBRICANTS/SEALANTS	
92-34227--1	Quicksilver Perfect Seal
92-825407A12	Quicksilver 2-C-4 Marine Lubricant with Teflon
92–91601-1	Quicksilver RTV Sealer

Engine Specifications

UNIT OF MEASUREMENT in. (mm)

Model	3.0L/3.0LX
Displacement	181 CID (3.0L)

CYLINDER BORE

Diameter			3.9995-4.0025(101.588-101.790)
Out of Round		Production	.0005(0.012) Max
		Service	.002(0.05) Max
Taper	Production	Thrust Side	.0005(0.012) Max
		Relief Side	.0005(0.012) Max
	Service		.001(0.02) Max

PISTON CLEARANCE

Production	.0025-.0035(0.064-0.088) Max
Service	.0035(0.08) Max

PISTON RING: COMPRESSION

Groove Clearance	Production	Top	.0012-.0029(0.030-0.073)
		2nd	
	Service		.003(0.09) Max
Gap	Production	Top	.010-.020(0.254-0.762)
		2nd	
	Service		.035(0.88) Max

PISTON RING: OIL

Groove Clearance	Production	.001-.006(0.026-0.152)
	Service Limit	.007(0.17) Max
Gap	Production	.010-.030(0.254-0.762) Max
	Service Limit	.040(1.01) Max

PISTON PIN

Diameter		.9270-.9271(23.546-23.550)
Clearance	Production	.0003–.0006(0.008-0.016)
	Service Limit	.001(0.02) Max
Fit in Rod		.0008-.0019(0.020-0.050) Interference

CRANKSHAFT

Main Journal	Diameter		2.2979-2.294(58.367-58.404)
	Taper	Production	.0002(0.005) Max
		Service	.001(0.02) Max
	Out of Round	Production	.0002(0.005) Max
		Service	.001(0.02) Max
Main Bearing Clearance	Production	No.1-No.4	.001-.0024(0.025-0.060)
	Service	No.5	.0016-.0035(0.041-0.088)
	Production	No.1-No.4	.001-.0025(0.03-0.06)
	Service	No.5	.002-.0035(0.05-0.08)
Crankshaft End Play			.002-.006(0.05-0.15)
Crankpin	Diameter		2.09980-20995(53.289-53.327)
	Taper	Production	.0003(0.007) Max
		Service	.001(0.02) Max
	Out of Round	Production	.0002(0.51) Max
		Service	.001(0.02) Max
Rod Bearing Clearance	Production		.0017-.0027(0.044-0.0686)
	Service		
Rod Size Clearance			.006-.017(0.153-0.4318) Max

CAMSHAFT

Lobe Lift (Max.)	Intake	.2529(6.425)
	Exhaust	.2529(6.425)
Journal Diameter		1.8677-18697(47.440-47.490)
Camshaft End Play		.003-.008(0.08-0.2032) Max

CYLINDER HEAD

Gasket Surface Flatness	.003-.008in any 6 in.(152) or .007(0.15) Overall Max

VALVE SYSTEM

Lifter			Hydraulic
Rocker Arm Ratio			1.75 to 1
Collapsed Tappet Gap			3/4 Turn Down from Zero Lash
Face Angle		Intake	45°
		Exhaust	45°
Seat Angle (Intake & Exhaust)			46°
Seat Runout (Intake & Exhaust)			.002(0.05) Max
Seat Width		Intake	1/16 (.0625in). (1.16 mm)
		Exhaust	1/16-5/64 [.0625-.07812 in.] (1.6-2.0 mm)
Stem Clearance	Production	Intake	.0010-.0027(0.025-0.069)
		Exhaust	.0007-.0027(0.018-0.069)
	Service	Intake	.003(0.09) Max
		Exhaust	.004(0.11) Max
Spring	Free Length		2-1/16 in. (52 mm)
	Pressure	Valve Closed	100-110 lb. (136-149 N) at 1-19/32 in. (41 mm)
		Valve Open	208-220 lb. (282-300 N) at 1-7/32 in. (31 mm)
	Installed Height ± .031(8)	Intake	(1/32)1.6562(42)
		Exhaust	
Internal Damper			None

General

Some of the repairs in this section must be completed with engine removed from boat. Engine removal depends upon type of repair and boat design. Place engine on repair stand for major repairs.

When engine removal is not required, make certain that battery cables are disconnected at the battery prior to performing any on-board engine repair procedure.

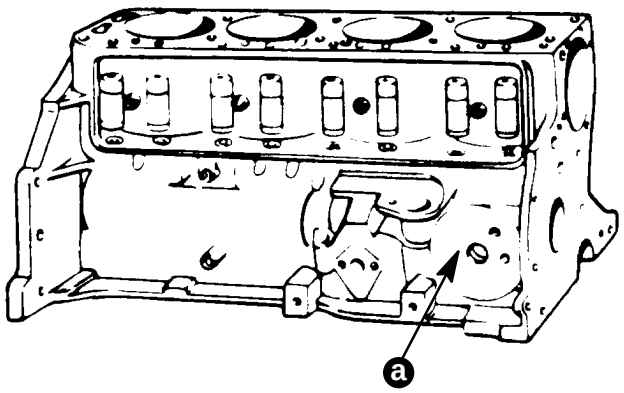
Lubricate all moving parts (during reassembly) with engine oil. Apply Quicksilver Perfect Seal on threads of and under heads of cylinder head bolts, and on threads of all cylinder block external bolts, screws and studs.

Model	No. of Cylinders	Cu. In./Litres Displacement
MCM 3.0L/3.0LX	4	181 (3L)

Engine Identification

The MerCruiser Model can be determined by looking at the LAST TWO LETTERS of the engine code stamped into the cylinder block. This code number is stamped on all MerCruiser power packages and replacement partial engines, but not replacement cylinder block assemblies.

If the engine serial number and/or model decals are missing, the engine code letters may help in determining the engine models.



74520

3.0L uses the 2.5L cylinder head
3.0LX uses the 3.0L cylinder head

a - 4 Cylinder-In-Line Engine Code (Next To Distributor)

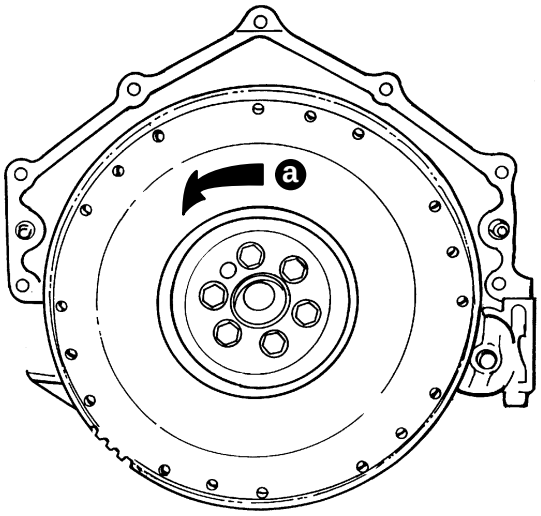
G.M. Engine Code Location
MCM Stern Drive Engines (LH Rotation)
3.0L - RM, RJ
3.0LX - RN, RK

Index

Engine Rotation

Engine rotation terminology at times has caused confusion. To clarify, engine rotation is determined by observing flywheel rotation from the rear (transmission or stern drive end) of the engine looking forward (water pump end).

PROPELLER ROTATION IS NOT NECESSARILY THE SAME as engine rotation. Do not rely on propeller rotation in determining engine rotation.

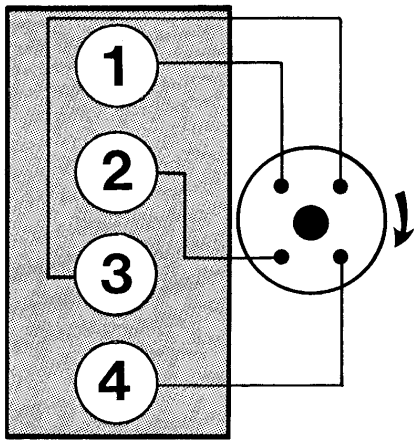


72001

a - Left-Hand Rotation (CCW) - All Stern Drive Engines

Firing Order

1-3-4-2

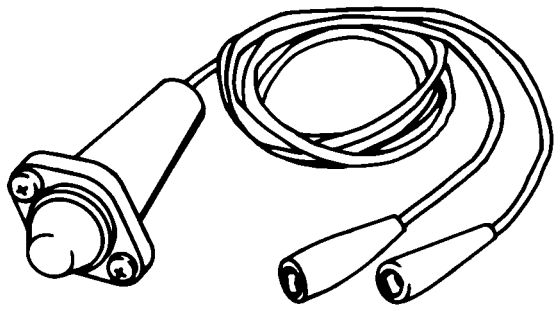


Priming Engine With Oil

IMPORTANT: This applies to all power packages that have not been run within 6 months, replacement of partial engines or after rebuilding an engine.

Tool Required

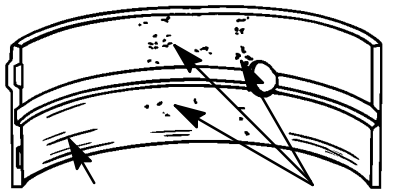
91-52024A1 Remote Starter Kit



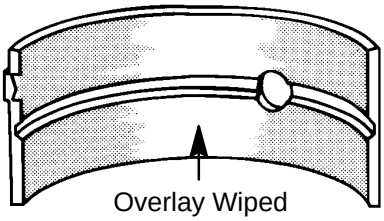
71089

1. Fill crankcase to proper level with the recommended engine oil.
2. Remove spark plugs.
3. Leave ignition key in ”OFF” position.
4. Connect remote starter switch (91-52024A1) to large 12 V terminal (RED battery cable) and small terminal (RED/YELLOW) wire on starter motor.
   a. If remote starter switch is not available, disconnect PURPLE wire from ignition coil before using key switch to crank the engine over. Tape terminal on PURPLE wire to prevent it from touching ground.
5. Crank engine for 15 seconds, then allow starter motor to cool down for 1 minute. This should prevent starter motor from overheating.
6. Repeat this process until a total of 45 seconds of cranking time is achieved.
7. Remove remote starter switch.
   a. If key switch was used, reconnect PURPLE wire to ignition coil.
8. Install spark plugs and wires
9. Supply cooling water to seawater pump and start motor.

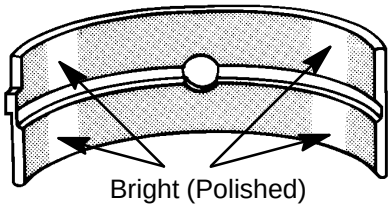
Bearing Failures



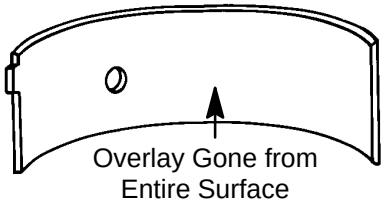
Scratched by Dirt



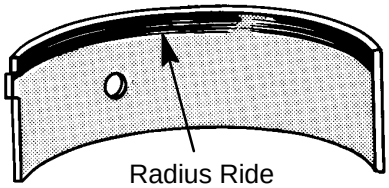
Lack of Oil



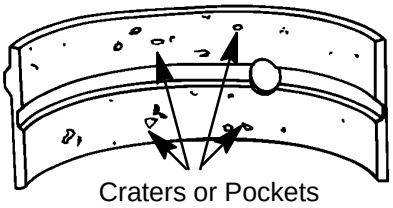
Improper Seating



Tapered Journal



Radius Ride



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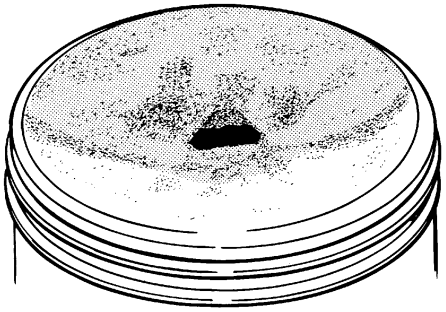
Fatigue Failure

Piston Failures

Pre-Ignition

Pre-ignition is abnormal fuel ignition, caused by combustion chamber hot spots. Control of the start of ignition is lost, as combustion pressure rises too early, causing power loss and rough running. The upward motion on the piston is opposed by the pressure rise. This can result in extensive damage to the internal parts from the high increase in combustion chamber temperature.



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Pre-Ignition Damage

PRE-IGNITION CAUSES

1. Hot spots in the combustion chamber from glowing deposits (due in turn to the use of improper oils and/or fuels).
2. Overheated spark plug electrodes (improper heat range or defective plug).
3. Any other protuberance in the combustion chamber, such as an overhanging piece of gasket, an improperly seated valve or any other inadequately cooled section of material which can serve as a source.

Engine failures, which result from the foregoing conditions, are beyond the control of Mercury Marine; therefore, no warranty will apply to failures which occur under these conditions.

Detonation

Detonation, commonly called “fuel knock,” “spark knock” or “carbon knock,” is abnormal combustion of the fuel which causes the fuel to explode violently. The explosion, in turn, causes overheating or damage to the spark plugs, pistons, valves and, in severe cases, results in pre-ignition.

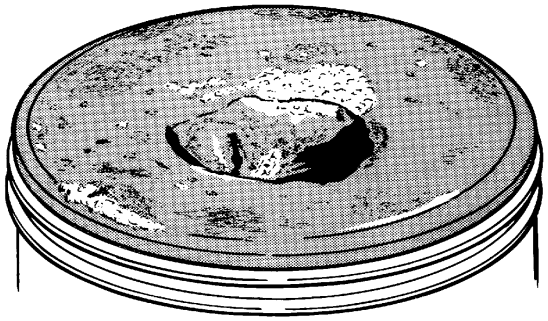
Use of low octane gasoline is one of the most common causes of detonation. Even with high octane gasoline, detonation could occur if engine maintenance is neglected.

OTHER CAUSES OF DETONATION

IMPORTANT: Use of improper fuels will cause engine damage and poor performance.

1. Over-advanced ignition timing.
2. Lean fuel mixture at or near full throttle (could be caused by carburetor or leaking intake manifold).
3. Cross-firing spark plugs.
4. Excess accumulation of deposits on piston and/or combustion chamber (results in higher compression ratio).
5. Inadequate cooling of engine by deterioration of cooling system.

Engine failures, which result from the foregoing conditions, are beyond the control of MerCruiser; therefore, no warranty will apply to failures which occur under these conditions.



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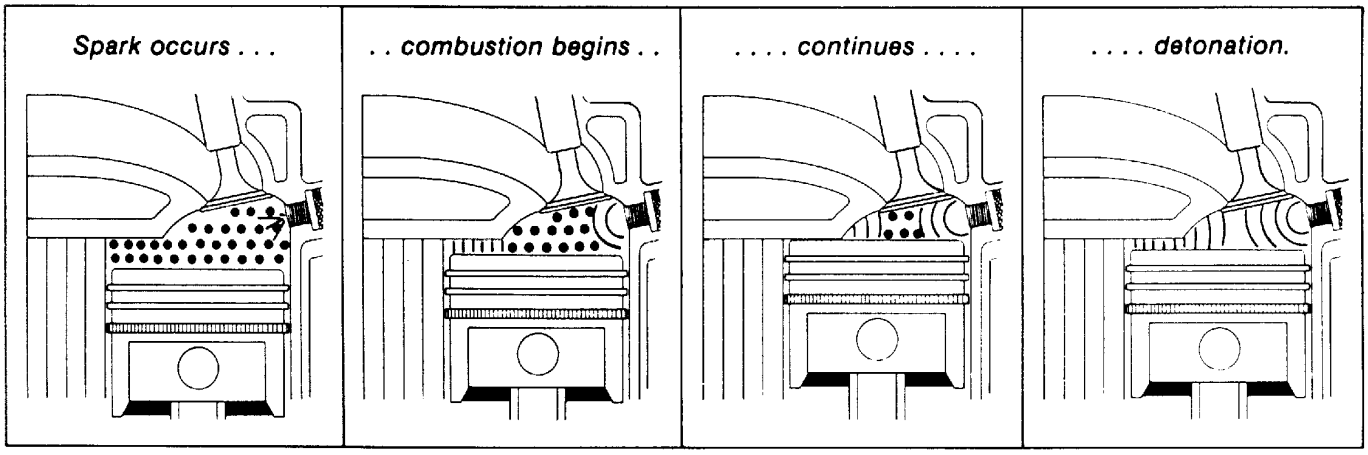
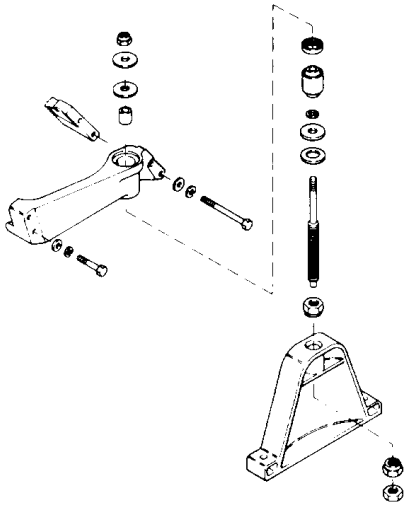
Detonation Damage



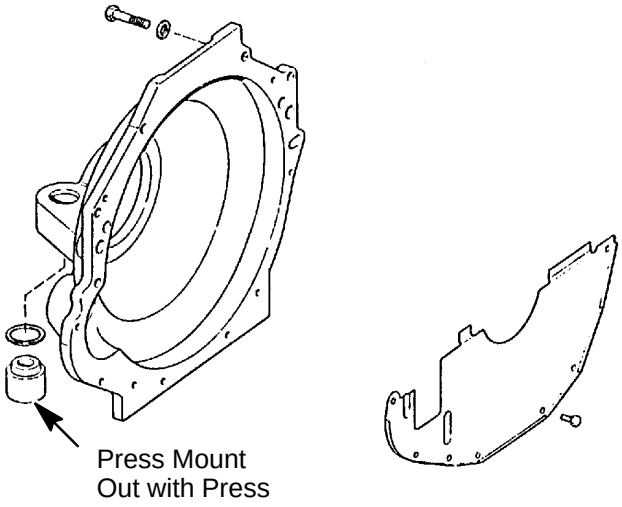
72315

Engine Mounts



74275

Front Mount



72318

Rear Mount/Flywheel Housing

Rocker Arm Cover

Removal

It may be necessary to remove exhaust manifold before removing rocker arm cover. Refer to Section 7B for removal.

1. Disconnect crankcase ventilation hoses.
2. Remove any items that interfere with the removal of rocker arm covers.

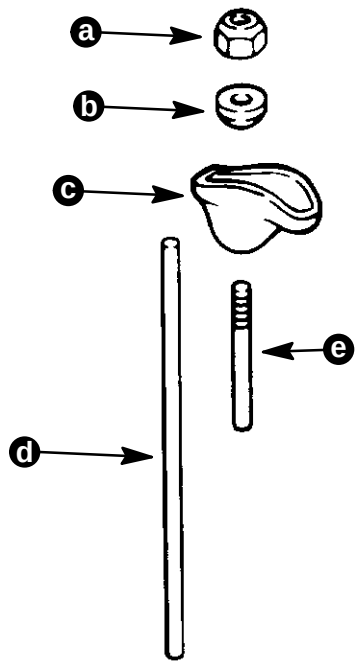
IMPORTANT: DO NOT pry rocker arm cover loose. Gaskets, which may adhere to cylinder head and rocker arm cover, may be loosened by bumping end of rocker cover from the rear with palm of hand or a rubber mallet.

3. Remove rocker arm cover.

Installation

1. Clean sealing surfaces on cylinder head and rocker arm cover with degreaser.
2. Place new rocker arm cover gasket in position in rocker arm cover.
3. Install rocker arm cover. Torque screws to 40 lb. in. (4.5 N·m).
4. Install exhaust manifolds, if removed.
5. Install any items which were removed to allow removal of rocker arm covers.
6. Connect crankcase ventilation hoses to rocker arm covers.

Rocker Arm/Push Rod



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Valve Mechanism

a - Nut
b - Ball Unit
c - Rocker Arm
d - Push Rod
e - Rocker Arm Stud

Removal

NOTE: *When servicing only one cylinder's rocker arms, bring that cylinder's piston up to TDC before removing rocker arms. When servicing all rocker arms, bring No. 1 piston up to TDC before removing rocker arms.*

1. Remove rocker arm covers as outlined.
2. Remove rocker arm assemblies and push rods.

IMPORTANT: Place rocker arm assemblies and push rods in a rack for reassembly in their original locations.

Cleaning and Inspection

1. Clean parts with solvent and dry with compressed air.
2. Inspect all contact surfaces for wear. Replace all damaged parts.

Installation

IMPORTANT: When installing rocker arms and rocker arm balls, coat bearing surfaces of rocker arms and rocker arm balls with engine oil.

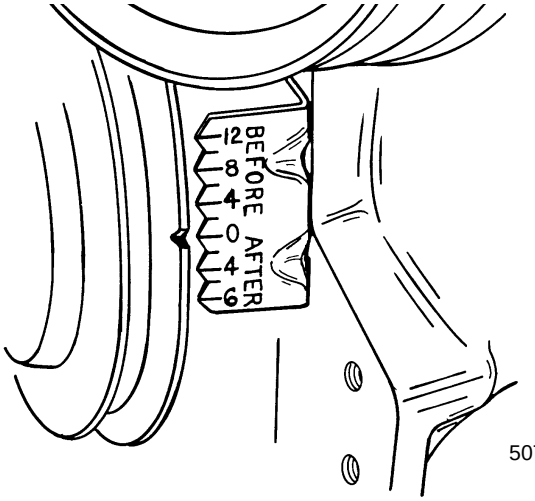
1. Install push rods in their original locations. Be sure push rods seat in lifter socket.
2. Install rocker arms, rocker arm balls and rocker arm nuts in their original locations.
3. Torque rocker arm nuts to 20 lb. ft. (27 N·m). No valve adjustment is required. Valve lash is automatically set when rocker arm nuts are torqued to specification.
4. Adjust carburetor idle speed and mixture.

Valve Adjustment

Engine Not Running

With valve cover removed, adjust valves when lifter is on low part of camshaft lobe, as follows:

1. Crank engine with starter or turn over in normal direction of rotation until mark on torsional damper lines up with center “0” mark on timing tab, and engine is in No. 1 firing position. This may be determined by placing fingers on No. 1 valve as mark. If valves move as mark comes up to timing tab, engine is in No.4 firing position and should be turned over one more time to reach No. 1 position.



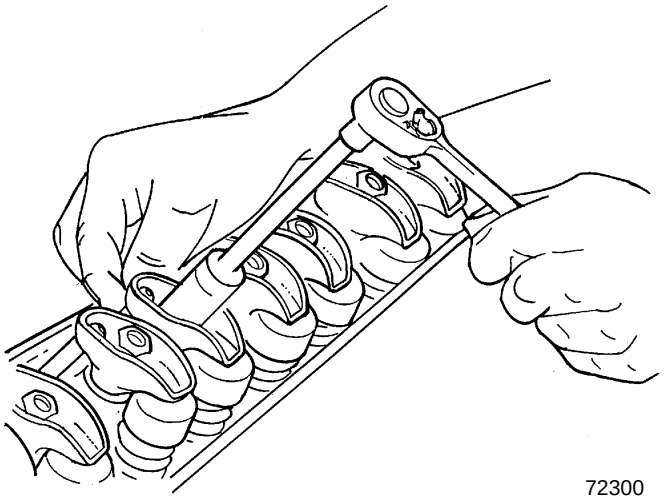
50770

No. 1 Cylinder - Exhaust and Intake
No. 2 Cylinder - Intake
No. 3 Cylinder - Exhaust
No. 4 Cylinder - Intake

2. With engine in No. 1 firing position as determined above, the following valves may be adjusted:
3. Back out adjusting nut until lash is felt at push rod, then turn in adjusting nut until all lash is removed. This can be determined by moving push rod up-and-down while turning adjusting nut until all play is removed.
4. Hydraulic lifters now can be adjusted by tightening adjustment nut an additional 3/4-turn. Valve lash should be checked after engine has run and reached operating temperature.
5. Crank engine one revolution until pointer “0” mark and torsional damper mark are again in alignment. This is No. 4 firing position. With engine in this position, the following valves may be adjusted:

No. 2 Cylinder - Exhaust
No. 3 Cylinder - Intake
No. 4 Cylinder - Exhaust

6. Install distributor cap, spark plug wires and coil lead.
7. Install rocker arm cover; torque to 40 lb. in. (4.5 N·m).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Engine Running

Following procedure should be completed only if readjustment is required.

1. Run engine until it reaches normal operating temperature, then remove valve cover.
2. With engine running at idle, back off valve rocker arm nut until valve rocker arm starts to clatter.
3. Turn rocker arm nut down slowly until clatter just stops. This is zero lash position.
4. Turn nut down 1/4 additional turn and pause 10 seconds until engine runs smoothly. Repeat additional 1/4 turns, pausing 10 seconds each time, until nut has been turned down 3/4 turn from zero lash position.

IMPORTANT: The following preload adjustment must be done slowly to allow lifter to adjust itself, thus preventing possibility of the valve head contacting the top of piston, which may result in internal damage and/or bent push rods.

Index

5. Repeat Steps 2-3-4 to adjust other valves.
6. Install valve covers, torque screws to 40 lb. in. (4.5 N·m).
7. Adjust carburetor idle mixture and idle speed. Check for leaks.

Hydraulic Valve Lifters

Hydraulic valve lifters require little attention. Lifters are extremely simple in design. Normally, readjustments are not necessary and servicing requires only that care and cleanliness be exercised in the handling of parts.

Locating Noisy Lifters

Locate a noisy valve lifter by using a piece of garden hose approximately 4 ft. (1.2 m) in length. Place one end of hose near end of each intake and exhaust valve, with other end of hose to the ear. In this manner, sound is localized, making it easy to determine which lifter is at fault.

Another method is to place a finger on face of valve spring retainer. If lifter is not functioning properly, a distinct shock will be felt when valve returns to its seat.

General types of valve lifter noise are as follows:

1. Hard rapping noise - usually caused by plunger becoming tight in bore of lifter body so that return spring cannot push plunger back up to working position. Probable causes are:
   a. Excessive varnish or carbon deposit, causing abnormal stickiness.
   b. Galling or “pickup” between plunger and bore of lifter body, usually caused by an abrasive piece of dirt or metal wedged between plunger and lifter body.
2. Moderate rapping noise - probable causes are:
   a. Excessively high leakdown rate.
   b. Leaky check valve seat.
   c. Improper adjustment.
3. General noise throughout valve train - this will, in most cases, be a definite indication of insufficient oil supply or improper adjustment.
4. Intermittent clicking - probable causes are:
   a. A microscopic piece of dirt momentarily caught between ball seat and check valve ball.
   b. In rare cases, ball itself may be out of round or have a flat spot.
   c. Improper adjustment.

In most cases, where noise exists in one or more lifters, all lifter units should be removed, disassembled, cleaned in solvent, reassembled and reinstalled in engine. If dirt, corrosion, carbon, etc., is shown to exist in one unit, it more likely exists in all the units; thus it would only be a matter of time before all lifters caused trouble.

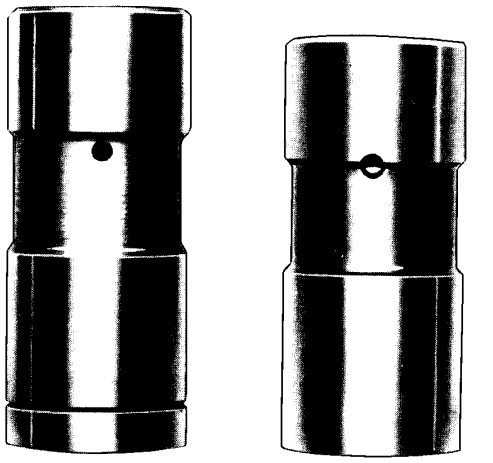
Removal

1. Remove as previously outlined:
   a. Rocker arm covers.
   b. Intake manifold.

IMPORTANT: Keep valve push rod and hydraulic lifter from each valve together as a matched set and mark or store them so they can be reinstalled in the same location later.

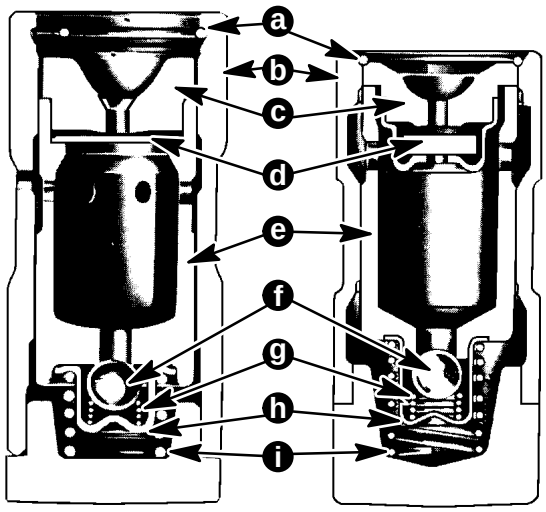
   c. Rocker arm assemblies and push rods.
2. Remove fasteners from lifter retainers (restrictors) and remove retainers. Do not disturb lifters at this time.

3. Make matching marks on all retainers and lifters as to location and orientation in bores, to allow reassembly in exact position on camshaft lobes (so that the roller's bearing and roller will roll in the same direction on the same lobe, if reused). Remove valve lifters.



05030

LIFTER "A" LIFTER "B"



05030

LIFTER "A" LIFTER "B"

a - Push Rod Seat Retainer
b - Lifter Body
c - Push Rod Seat
d - Metering Valve (Lifter "A")
Inertia Valve (Lifter "B")
e - Plunger
f - Check Ball
g - Check Ball Spring
h - Check Ball Retainer
i - Plunger Spring

Cleaning and Inspection

1. Thoroughly clean all parts in cleaning solvent and inspect them carefully.
2. If any parts are damaged or worn, entire lifter assembly should be replaced.
3. If outer lifter body wall is scuffed or worn, inspect cylinder block lifter bore.
4. If push rod seat is scuffed or worn, inspect push rod.

Installation

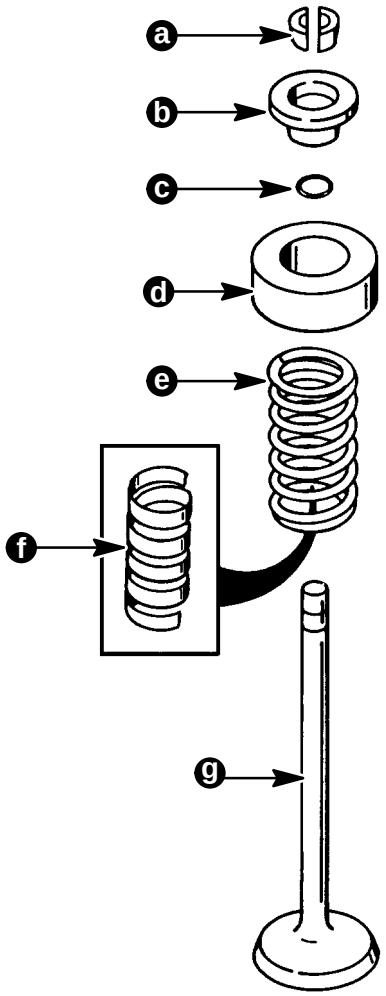
IMPORTANT: It is recommended that the engine oil be changed and a new oil filter be installed whenever servicing valve lifters or camshaft.

IMPORTANT: Before installing lifters, coat the lifter with engine oil. If new lifters or a new camshaft have been installed, an additive containing EP lube (such as General Motors Cam and Lifter Prelube or equivalent) should be poured over camshaft lobes before installing lifters.

IMPORTANT: DO NOT install used valve lifters if a new camshaft has been installed.

1. Install valve lifters into bores.
2. Install push rod covers, using new gaskets and torque to specification.
3. Install distributor, positioning rotor to number 1 cylinder position, then connect primary lead at coil.
4. Install distributor cap and spark plug wires.
5. Adjust valves to specifications.
6. Adjust ignition timing, carburetor idle speed and mixture.

Valve Stem Oil Seal/Valve Spring

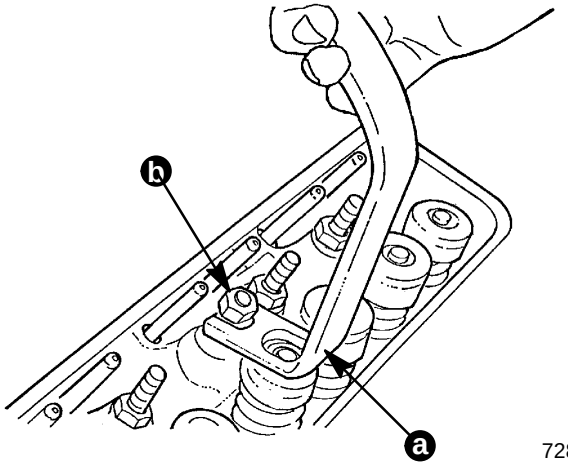


50841

a - Keys (2 per Valve)
b - Cap
c - Seal (On LX **Models**, These Are Used Only On Intake Valve Stems **Do Not** Install Them On Exhaust Valve Stems)
d - Valve Spring Shield
e - Valve Spring
f - Damper, Internal
g - Valve

Replacement Oil Seal Head Installed

1. Remove rocker arm cover.
2. Remove spark plug, rocker arm and push rod on cylinder to be serviced.
3. Place piston for that cylinder at TDC to prevent valves from dropping into the cylinder.
4. Compress valve spring with tool (J-5892) and remove valve keys, valve spring cap, spring shield and valve spring.



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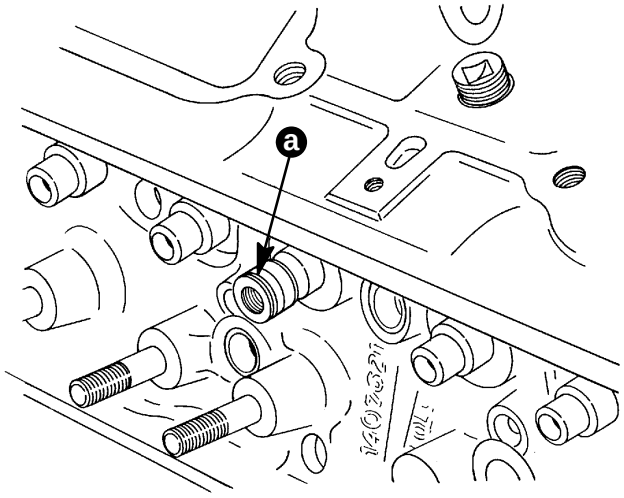
a - Valve Spring Compressor (J-5892)
b - Rocker Arm Nut

5. Remove valve stem oil seal.



72330

a - Valve Guide Seal

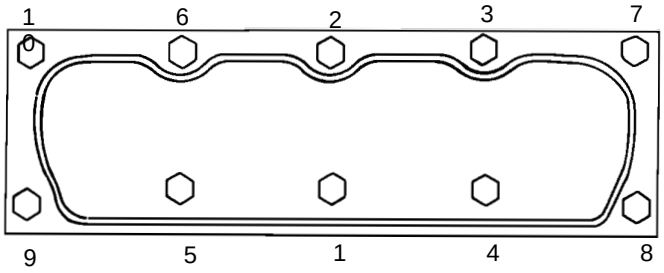
6. To install, set valve spring, (close, coiled end of spring is installed against cylinder head) valve shield and valve cap in place. Compress spring with tool (J-5892) and install oil seal in lower groove of stem, making sure that seal is flat and not twisted.

NOTE: *A light coat of oil on seal will help prevent twisting when compressor tool is released.*

IMPORTANT: Do not turn crankshaft while valve springs, retainers, and locks are removed or valves will fall into cylinder.

7. Install valve keys and release compressor tool. Be sure that keys seat properly in upper groove of valve stem.
8. Install push rods and rocker arm assemblies.
9. Torque rocker arm nuts to 20 lb. ft. (27 N·m).
10. Install rocker arm cover and torque to 40 lb. in. (4.5 N·m). Install spark plug, and torque to 15 lb. ft. (20 N·m).
11. Install spark plug and torque to specifications.
12. Repeat steps 2 thru 8 for other cylinders.

Cylinder Head



Cylinder Head Torque Sequence

1. Drain engine cooling system.
2. Remove as outlined:
   a. Exhaust manifolds.
   b. Intake manifold.
   c. Rocker arm covers.
   d. Rocker arm assemblies and push rods (keep in order for reassembly in their original locations).
   e. Any components attached to front or rear of cylinder head.
   f. Spark plugs.
   g. Head bolts.

⚠CAUTION

The head gasket may be holding cylinder head to block. Use care when prying off cylinder heads. DO NOT damage gasket surfaces. DO NOT drop cylinder heads.

3. Place cylinder head on wooden blocks to prevent damage to gasket surfaces.

Cleaning and Inspection

1. Clean gasket material and sealer from engine block and cylinder heads.
2. Inspect sealing surfaces for deep nicks and scratches.
3. Inspect for corrosion around cooling passages.
4. Clean head bolt threads and engine block bolt hole threads, making sure no dirt, old oil or coolant remain.

Installation

⚠CAUTION

When using ribbed stainless steel head gaskets, apply a thin coating of Quicksilver Perfect Seal to both sides of gasket. Too much sealer may hold gasket away from head or block causing leakage. DO NOT use sealer on graphite composition head gaskets.

1. Place head gasket in position over dowel pins.
2. Carefully set cylinder head in place over dowel pins.
3. Coat threads of head bolts with Quicksilver Perfect Seal and install finger-tight.
4. To insure gasket sealing, torque head bolts in torque sequence to 90 lb. ft. (122 N·m).
5. Install push rods, rocker arm assemblies and lifter restrictors in their original positions.
6. Torque rocker arm nuts to 20 lb. ft. (27 N·m).

7. Install as outlined:
   a. Intake manifold.
   b. Rocker arm covers.
   c. Exhaust manifolds.
   d. Spark plugs.
   e. Any components removed from front or rear of cylinder heads.
8. Follow procedures in SECTION 6A or 6B of this manual:

   Seawater Cooled Models: Provide for adequate water supply to seawater pickup (see SECTION 6A).

   Closed Cooled Models: Refill closed cooling section (see SECTION 6B), and provide adequate water supply to seawater pickup.

⚠CAUTION

Ensure that cooling water supply is available before starting the engine.

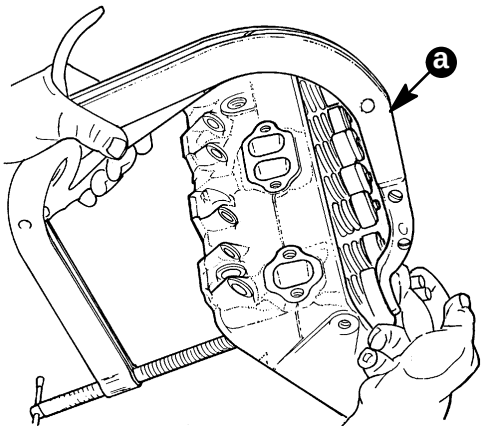
9. Start engine, set timing, set idle speed, and check for leaks.

Cylinder Head and Valve Conditioning

Disassembly

NOTE: *On LX models, O-ring seals are used only on intake valve stems.*

1. Using valve spring compressor, compress valve spring (J-8062) and remove valve locks. Slowly release tool.
2. Remove all valve components.
3. Remove valves from cylinder head and place in a rack, in order, for reassembly in their original locations.

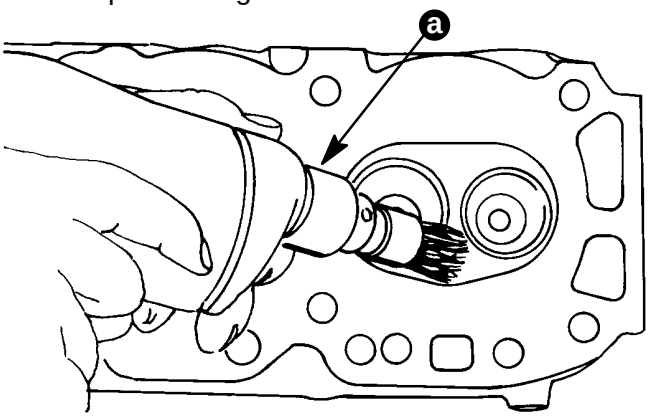


72333

a - Valve Spring Compressor (J-8062)

Cleaning

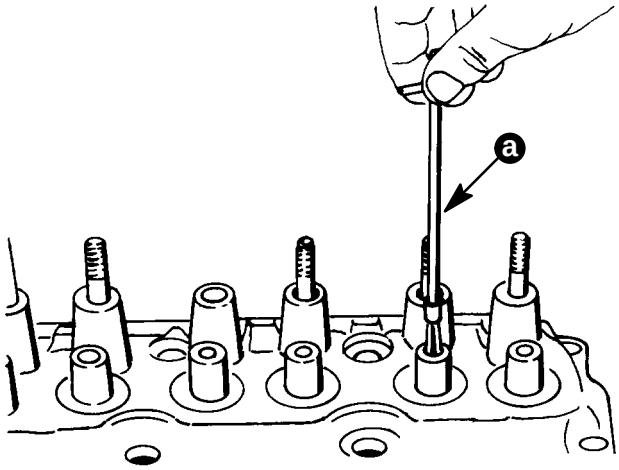
1. Clean push rods and rocker arm assemblies.
2. Clean carbon from valves using tool (J-80890).
3. Clean gasket material from cylinder head mating surfaces.
4. Clean all carbon from combustion chambers and valve ports using carbon remover brush.



74274

a - Carbon Remover Brush (J-8089)

5. Thoroughly clean valve guides with valve guide cleaner (J-8101).

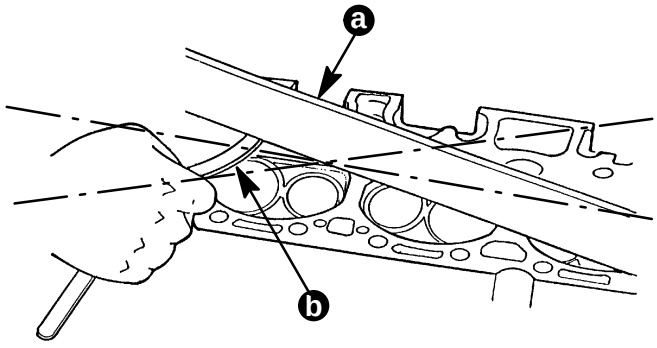


74286

a - Valve Guide Cleaner (J-8101)

Inspection

1. Inspect cylinder head for cracks in exhaust ports, water jackets, and combustion chambers (especially around spark plug holes and valve seats). Replace heads if any cracks are found.
2. Inspect cylinder head gasket surface for burrs, nicks, or erosion or other damage. Also, check flatness of cylinder head gasket surface, using a machinist's straight edge and feeler gauges as shown. Refer to "Specifications."



72885

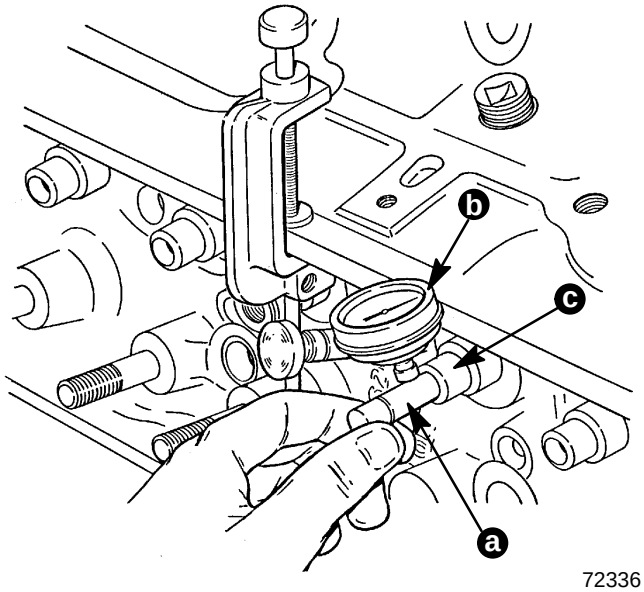
a - Straight Edge
b - Feeler Gauge
c - Take Measurements Diagonally Across Head (Both Ways) and Straight Down Center Head

IMPORTANT: Cylinder head-to-block gasket surface should be resurfaced if warped more than specified. When head resurfacing is required, cylinder head-to-intake manifold gasket surface on head must be milled to provide proper alignment between intake manifold and head.

3. Inspect valves for burned heads, cracked faces or damaged stems.

IMPORTANT: Excessive valve stem to bore clearance will cause excessive oil consumption and possible valve breakage. Insufficient clearance will result in noisy and sticky valves.

4. Measure valve stem clearance as follows:
   a. Attach a dial indicator to cylinder head, positioning it against the valve stem and close to the valve guide.
   b. Holding valve head off seat about 1/16 in. (2 mm), move valve stem back and forth in direction shown. Compare stem clearance with specifications.
   c. If clearance exceeds specifications, it will be necessary to ream valve guides for oversized valves, as outlined under "Valve Guide Bore Repair."



72336

a - Valve Stem
b - Dial Indicator
c - Valve Guide

Rocker Arm Studs

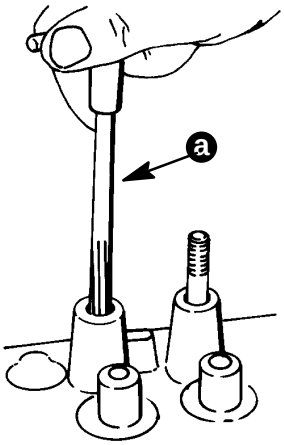
Rocker arm studs with damaged threads or with loose fit in cylinder heads should be replaced with new, oversize studs. Studs may be installed after reaming holes as follows:

1. Drain water from cylinder block.
2. Remove old stud by placing Tool J-5802-01 over stud, installing nut and flat washer and removing stud by turning nut.

74288

a - Tool J-5802-01

3. Ream hole for oversize stud with Tool J-5715 for .003 in. oversize or Tool J-6036 for .013 in. oversize.



74289

a - Reamer Tool J-5715

IMPORTANT: Do not attempt to install an oversize stud without reaming stud hole.

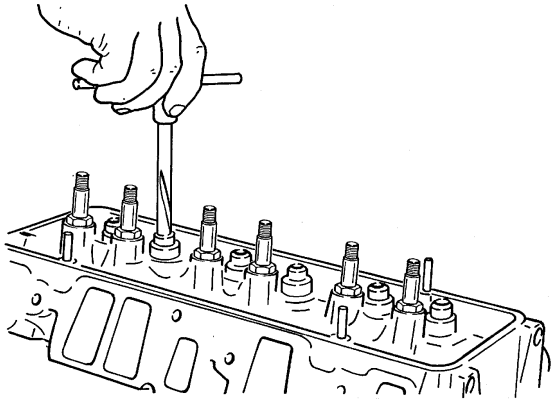
4. Coat press-fit area of stud with Perfect Seal. Install new stud, using Tool J-6880 as a guide. Gauge should bottom on head.

Valve Guide Bore Repair

IMPORTANT: Be sure to measure valve stem diameter of both the intake and exhaust valve, as valve stem diameter may or may not be the same for both valves.

If .015 in. oversize valve stems are required, ream valve guide bores for oversize valves, as follows:

1. Measure valve stem diameter of old valve being replaced and select proper size valve guide reamer from chart below.
2. Ream valve guide bores, as shown.



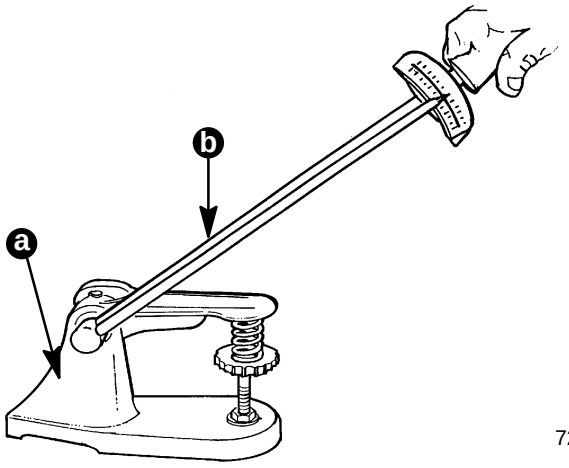
72886

3. Remove the sharp corner created by reamer at top of valve guide.

Valve Springs - Checking Tension

Using valve spring tester, as shown, check valve spring tension with dampers removed. Refer to “Specifications.”

IMPORTANT: Springs should be replaced if not within 10 lbs. (44 N) of specified tension.



72308

a - Valve Spring Tester (J-8056)
b - Torque Wrench

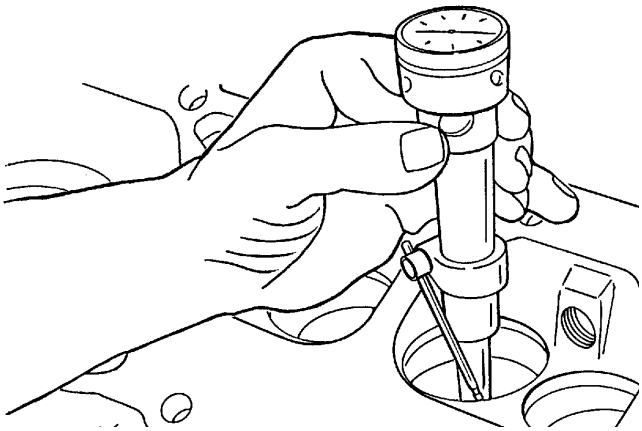
Valve Seats

Valve seat reconditioning is very important, since seating of valves must be perfect for engine to deliver maximum power and performance.

Another important factor is valve head cooling. Good contact between each valve and its seat in head is important to ensure that heat in valve head will be properly dispersed.

Several different types of equipment are available for reseating valve seats. Equipment manufacturer's recommendations should be followed carefully to attain proper results.

Regardless of type of equipment, however, it is essential that valve guide bores be free from carbon or dirt to achieve proper centering of pilot in valve guide, ensuring concentricity.

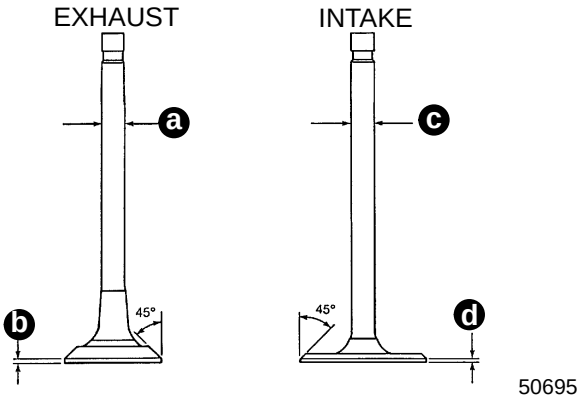


72338

a - Check Valve Seat Concentricity

Valves that are pitted must be refaced to the proper angle. Valve stems which show excessive wear, or valves that are warped excessively, must be replaced. When a valve head which is warped excessively is refaced, a knife edge will be ground on part or all of the valve head, due to the amount of metal that must be removed to completely reface. Knife edges lead to breakage, burning, or pre-ignition due to heat localizing on this knife edge. If the edge of the valve head is less than 1/32 in. (0.8 mm) after grinding, replace the valve.

Several different types of equipment are available for refacing valves. The recommendation of the manufacturer of the equipment being used should be carefully followed to attain proper results.



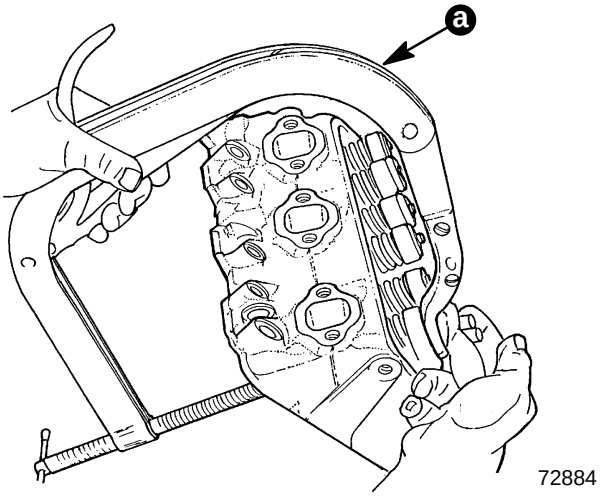
50695

Exhaust
a - .372 In. (9.45 mm)
b - 1/32 [.031] In. (0.79 mm) Min.
Intake
c - .341 In. (8.16 mm)
d - 1/32 [.031] In. (0.79 mm) Min.

Reassembly

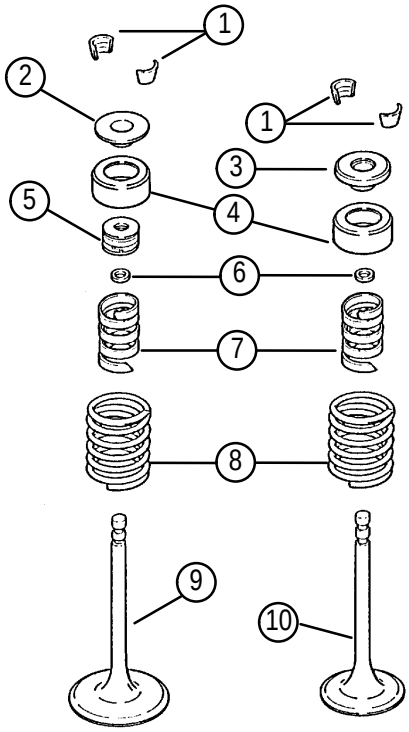
1. Lubricate valve guides and valve stems with engine oil.
2. Install each valve in the port from which it was removed or to which it was fitted.
3. Install valve guide seal (intake valve only) over valve stem and push down until seated against head.
4. Set valve spring (with damper installed) and cap in place.
5. Place retainer on intake valve and/or rotator on exhaust valve.

6. While compressing valve spring with valve spring compressor, install oil seal in lower groove of valve stem, making sure seal is not twisted. A light coating of oil will help prevent twisting.



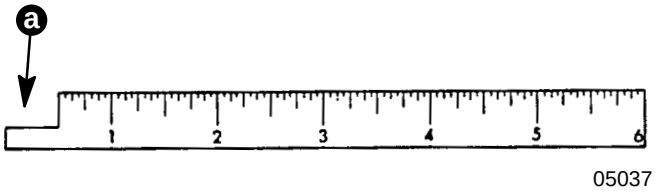
a - Valve Spring Compressor (J-8062)

7. Install valve locks (grease may be used to hold them in place) and slowly release tool, making sure locks seat properly in upper grooves of valve stem.

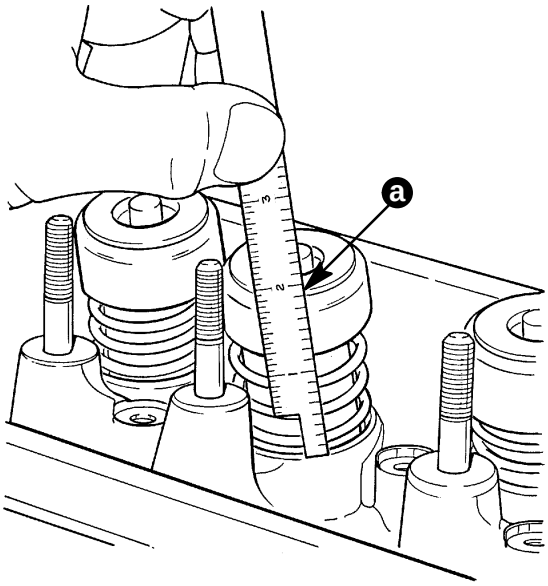


1 - Valve Locks
2 - Retainer
3 - Rotator
4 - Cap
5 - Valve Guide Oil Seal
6 - Valve Stem Oil Seal
7 - Damper
8 - Outer Spring
9 - Intake Valve
10 -Exhaust Valve

8. Check installed height of valve springs using a narrow, thin scale. Measure from spring seat to top of valve spring, as shown. If measurement exceeds specified height, install a valve spring shim and recheck. DO NOT shim valve springs to give an installed height less than the minimum specified.



a - Cut Out This Portion



a - Valve Spring Installed Height

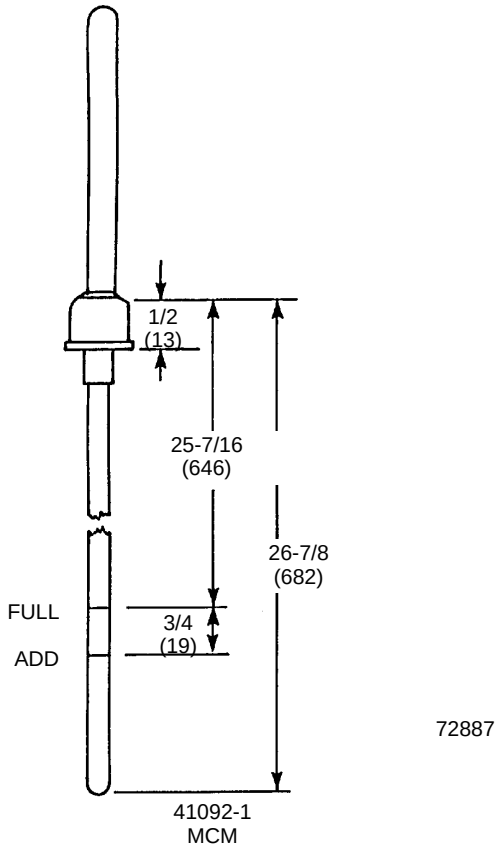
Checking Valve Spring Installed Height

Index

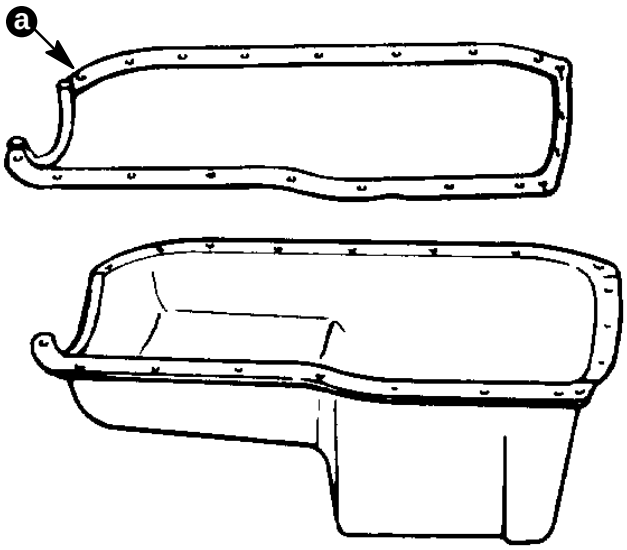
Dipstick Specifications

All Engines

UNIT OF MEASUREMENT In. (mm)



Oil Pan



a - 181 CID (3.0L) Engines - 1 piece oil pan gasket

Removal

1. Disconnect battery.

NOTE: *Removal of engine from boat may be required.*

2. Drain crankcase oil.
3. Remove starter motor.
4. Remove oil pan screws, oil pan, and gasket(s).

Installation

1. Clean sealing surfaces of engine block and oil pan.
2. Apply a small amount of Quicksilver RTV Sealer to joints of rear seal retainer and joints of front cover.

IMPORTANT: Quicksilver RTV Sealer sets up in about 15 minutes. Be sure to complete assembly promptly.

3. Install oil pan gasket in position as shown.

NOTE: *A one-piece oil pan gasket may be reused if it is still pliable and is not cracked, torn or otherwise damaged.*

4. Install oil pan. Starting from the center and working outward in each direction, tighten 1/4-20 threaded fasteners to 80 lb. in. (9 N·m) and 5/16-18 threaded fasteners to 165 lb. in. (19 N·m).
5. Install dipstick tube and dipstick.
6. Fill crankcase with required quantity of oil of specified viscosity. See Section 1B - "Maintenance."

Oil Pump

The oil pump consists of two gears and a pressure regulator valve enclosed in a two-piece housing. Oil pump is driven by distributor shaft which is driven by a helical gear on camshaft.

Removal

1. Remove oil pan as previously outlined.
2. Remove gasket carefully as the one-piece gasket for the oil pan may be reused if still pliable and not cracked, torn, etc.
3. Remove oil pump

Disassembly

1. Remove pump cover.

IMPORTANT: Mark gear teeth for reassembly with same teeth indexing.

2. Remove idler gear and drive gear from pump body.
3. Remove retaining pin, spring, and pressure regulator valve from pump cover.

IMPORTANT: Do not remove pickup screen and pipe assembly, unless replacement is necessary. Loss of press fit condition could result in an air leak and loss of oil pressure.

IMPORTANT: Do not disturb pickup screen on pipe. This is serviced as an assembly.

4. If pickup screen and pipe assembly requires replacement, mount pump in a soft-jawed vise and extract pipe from pump.

Cleaning and Inspection

1. Wash all parts in cleaning solvent and dry with compressed air.
2. Inspect pump body and cover for cracks or excessive wear.
3. Inspect pump gears for damage and excessive wear.
4. Check for loose drive gear shaft in pump body.
5. Inspect inside of pump cover for wear that would permit oil to leak past ends of gears.

IMPORTANT: Pump gears and body are not serviced separately. If pump gears or body are damaged or worn, replacement of entire oil pump assembly is necessary.

6. Inspect pickup screen and pipe assembly for damage to screen and pipe.
7. Check pressure regulator valve for fit.

Reassembly

⚠CAUTION

Be careful of twisting, shearing or collapsing pipe while installing in pump. Pickup screen must be parallel to oil pan bottom when oil pump is installed.

If pickup screen and pipe assembly was removed, mount pump in a soft-jawed vise, apply Quicksilver Perfect Seal to end of new pipe and, using oil pump suction pipe installer (J-21882), tap the pipe in place with a hammer.

IMPORTANT: Oil internal parts liberally before installation.

1. Install pressure regulator valve and related parts.
2. Install drive gear in pump body.
3. Install idler gear in pump body with smooth side of gear toward pump cover opening. Align marks made in disassembly.
4. Fill gear cavity with engine oil.

5. Install pump cover and torque attaching bolts to 80 lb. in. (9 N·m).
6. Turn extension shaft by hand to check for smooth operation.

Installation

1. Install pump, with extension shaft, to rear main bearing, aligning extension shaft with distributor drive shaft.
2. Tighten oil pump bolt to 65 lb. ft. (88 N·m).
3. Install oil pan as outlined. The one-piece gasket for the oil pan may be reused if still pliable and not cracked, torn, etc.

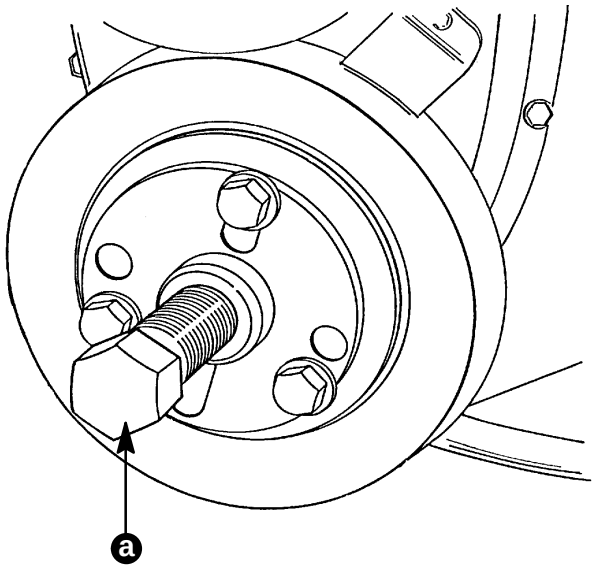
Torsional Damper

Removal

1. Support front of engine (if in boat) with overhead hoist.
2. Remove front mounting bracket and drive belt. (Remove retaining bolt, if so equipped.)
3. Install tool J-6978-E to balancer and turn puller Remove drive pulley, then remove torsional damper retaining bolt.

IMPORTANT: DO NOT use a universal claw type puller to remove torsional damper (in next step) as outside ring of torsional damper is bonded in rubber to the hub and use of claw type puller may break the bond.

4. Remove torsional damper with torsional damper remover and installer.



72890

a - Torsional Damper Remover and Installer (J-6978-E)

Installation

IMPORTANT: The inertia weight section of torsional damper is assembled to the hub with a rubber type material. The installation procedure (with proper tool) must be followed or movement of the inertia weight on the hub will destroy the tuning of the torsional damper.

1. Replace key in crankshaft if it is damaged.
2. Coat seal surface of torsional damper with engine oil.

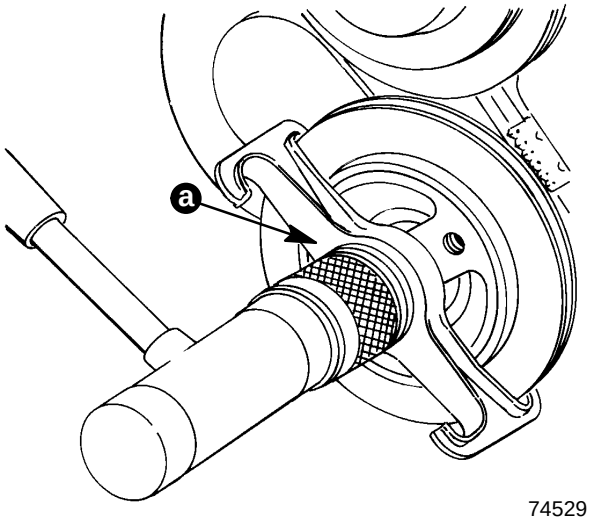
NOTE: *If a suitable torsional damper installer installation tool is not available, use a block of wood as a driver. Be very careful not to cause pulley or weight to shift on their rubber mounts.*

3. Install torsional damper on crankshaft, using torsional damper remover and installer as follows:
   a. Install appropriate end of threaded rod into crankshaft.

IMPORTANT: Be sure to install threaded rod in crankshaft at least 1/2 in. (13 mm) to prevent damage to threads.

   b. Install plate, thrust bearing, washer and nut on rod.

c. Install torsional damper on crankshaft by turning nut until it bottoms out.



a - Torsional Damper Remover and Installer (J-23523-E)

d. Remove tool from crankshaft.

e. To prevent oil leakage, apply Quicksilver RTV sealant to torsional damper keyway.

f. Install torsional damper bolt. Torque to 70 lb. ft. (95 N·m).

4. Install drive pulley(s). Torque bolts to 35 lb. ft. (48 N·m).
5. Install and adjust drive belts.

Crankcase Front Cover/ Oil Seal

Oil Seal Replacement (Without Removing Front Cover)

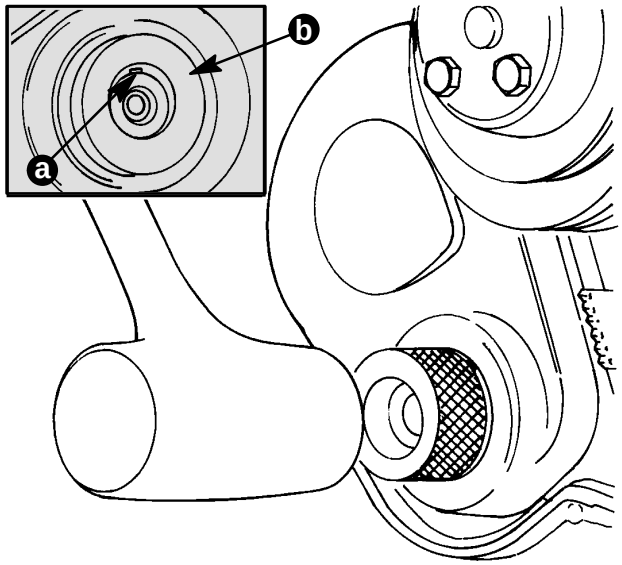
REMOVAL

1. Remove torsional damper.
2. Pry seal out of cover from the front with a large screwdriver, being careful not to distort front cover or damage crankshaft.

INSTALLATION

IMPORTANT: Correct rotation oil seal must be used to prevent oil leak.

1. Apply Quicksilver Perfect Seal to seal retainer mating surface and apply grease to seal lips.
2. Install new seal with open end of seal inward, using crankcase front cover seal installer. Drive seal in until it just bottoms out. Do not use excessive force.



a - Key In Crankshaft
b – Lobe of Bore Clears Key

3. Reinstall torsional damper as outlined.

Crankcase Front Cover

Removal

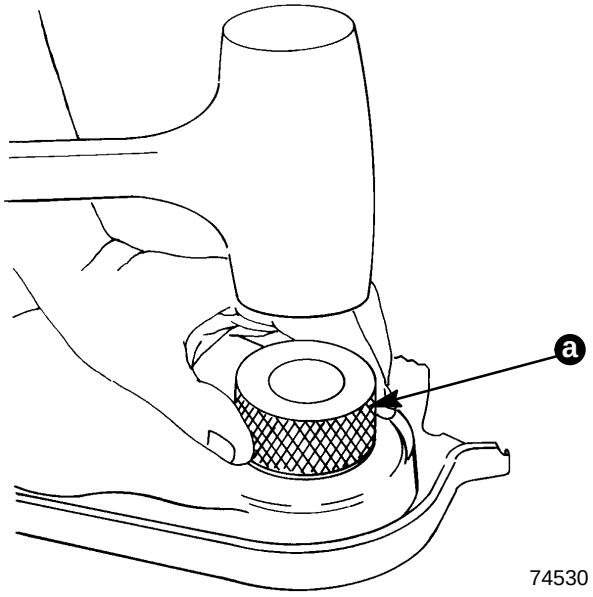
1. Remove engine from boat if necessary to gain access to cover.
2. Remove torsional damper and oil pan.
3. Remove water circulating pump.
4. Remove crankcase front cover.
5. If damaged, drive oil seal out of front cover (from the rear) using a punch.

Cleaning and Inspection

Clean front cover in solvent and dry with compressed air. Clean old gasket material and sealer from mating surfaces on cover and cylinder block. Check gasket surface on front cover for distortion, and true if necessary. Surfaces must be clean and flat or oil leakage may result.

Installation

1. Install oil seal in cover with lip of seal toward inside of engine, using crankcase front cover seal installer. Support cover around seal area with appropriate tool as shown.



74530

a - Crankcase Front Cover Seal Installer (J-35468)

2. Coat both sides of front cover gasket with Quicksilver Perfect Seal and place in position on engine.
3. Install front cover, making sure holes in cover align with dowel pins in block. Torque front cover attaching screws to 100 lb. in. (11 N·m).
4. Install oil pan and torsional damper as outlined.
5. Install water circulating pump.
6. Reinstall engine in boat.
7. Fill crankcase with engine oil.

⚠CAUTION

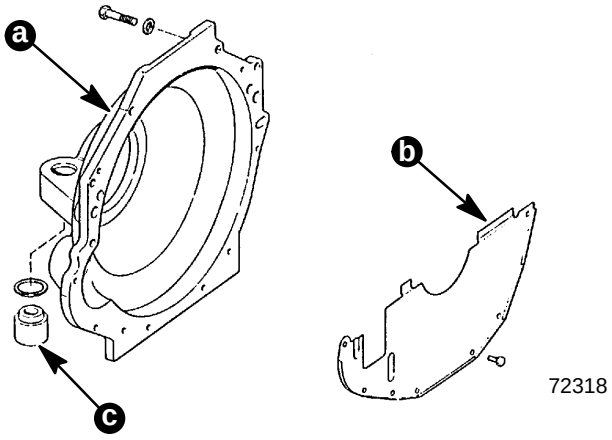
Ensure that cooling water supply is available before starting the engine.

8. Start engine and check for water and oil leaks.

Flywheel and Engine Coupler

Removal

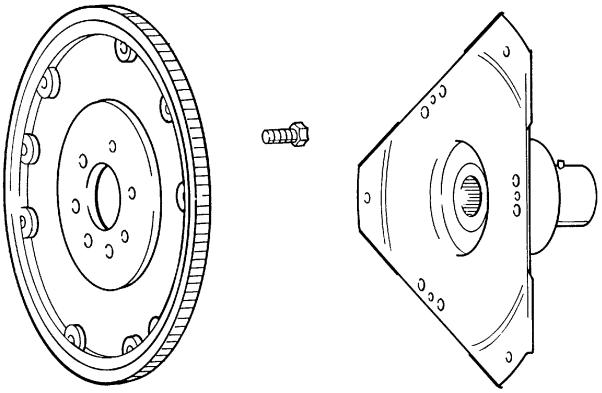
1. Remove engine from boat. Refer to SECTION 2 - “Removal and Installation”.
2. Refer to “Flywheel Housing” description in this section and remove flywheel housing and related parts.



72318

a - Flywheel Housing
b - Cover
c - Press Mount Out with Press

3. Remove MCM coupler.
4. Remove flywheel.



72349

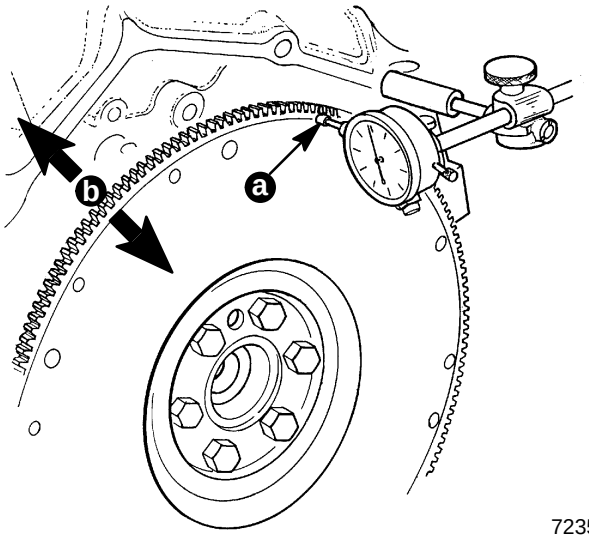
Alpha One Coupler

Inspection

1. Inspect splines in coupler for wear.
2. Check flywheel ring gear for worn and missing teeth.

Installation

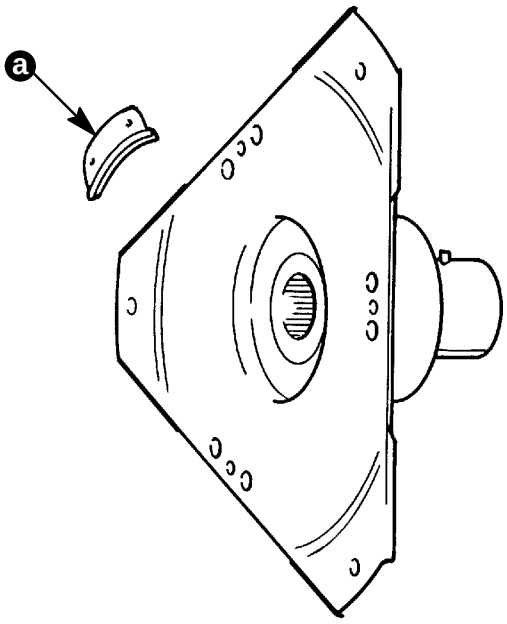
1. Clean mating surfaces of flywheel and crankshaft. Remove any burrs. Mating surfaces must be clean bare metal.
2. Aligning dowel hole in flywheel with dowel in crankshaft, install flywheel. Torque bolts to 75 lb. ft. (100 N·m).
3. Check flywheel runout as follows:
   a. Attach a dial indicator to engine block.
   b. Take readings around outer edge of flywheel. Push in on flywheel to remove crankshaft end play.
   c. Maximum runout - .008 in. (0.203 mm).



72353

a - .008 in. (0.203 mm) Max. Runout
b - Push Flywheel and Crankshaft Forward as Far as It Will Go when Taking Reading

4. Insert three rubber bumpers in Alpha coupler before installation on flywheel.



72354

a - Rubber Bumper

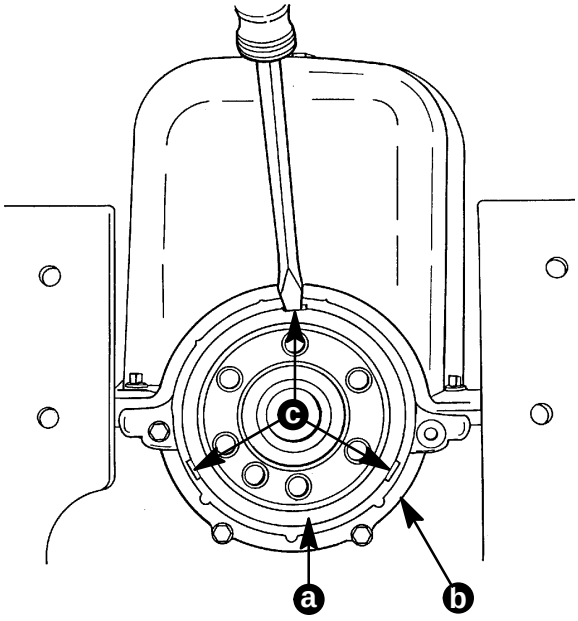
5. Install drive coupler. Torque bolts to 35 lb. ft. (48 N·m). If reusing screws, use Loctite 8831.
6. Install flywheel housing and related parts. Torque bolts to 30 lb. ft. (41 N·m).
7. Install flywheel housing cover. Torque bolts to 80 lb. in. (9 N·m).
8. Refer to SECTION 2 “Removal and Installation” and install engine.

Rear Main Oil Seal

The rear crankshaft oil seal can be replaced without removing the oil pan or rear main bearing cap from engine.

Removal

Remove seal by using a screwdriver to pry it out of retainer as shown.



72355

a - Rear Seal
b - Seal Retainer
c - Slots (Three)

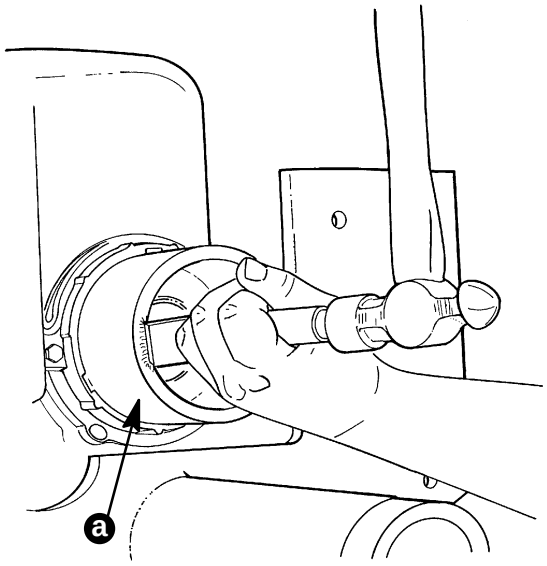
Cleaning and Inspection

Clean crankshaft/seal running surface and seal retainer.

IMPORTANT: Correct rotation oil seal must be used to prevent oil leak.

Installation

1. Apply Quicksilver Perfect Seal to seal retainer mating surface. Apply grease to seal lips.
2. Install seal using rear main seal installer.



72356

a - Rear Main Seal Installer (J-26817-A)

Cleaning and Inspection

1. Clean gasket material from mating surfaces.
2. Inspect oil seal retainer for cracks or scored surface.
3. Inspect oil seal for worn, dry or torn rubber. Replace if necessary (refer to “Rear Main Oil Seal” as outlined).
4. Inspect alignment pin for damage; replace if necessary.

Installation

1. Coat seal lips with clean motor oil.
2. Install gasket and oil seal retainer with rear main seal.
3. Coat threads of oil seal retainer fasteners with Loctite Pipe Sealant with Teflon.
4. Install fasteners and torque to 133 lb. in. (15 N·m).
5. Install oil pan fasteners. Torque 1/4-20 threaded fasteners to 80 lb. in. (9 N·m) and 5/16-18 threaded fasteners to 165 lb. in. (19 N·m).

NOTE: *A one-piece oil pan gasket may be re-used if it is still pliable and is not cracked, torn or otherwise damaged.*

Index

Main Bearings

IMPORTANT: Before removing main bearing caps or connecting rod caps, mark them for reassembly in their original locations.

Main bearings are of the precision insert type and do not use shims for adjustment. If clearances are found to be excessive, a new bearing, both upper and lower halves, will be required. Service bearings are available in standard size and .001 in., .010 in. and .020 in. undersize.

Selective fitting of both rod and main bearing inserts is necessary in production in order to obtain close tolerances. For this reason you may find one half of a standard insert with one half of a .001 in. undersize insert which will decrease the clearance .0005 in. from using a full standard bearing.

When a production crankshaft cannot be precision fitted by this method, it then is ground .009 in. undersize on main journals only. A .009 in undersize bearing and .010 in. undersize bearing may be used for precision fitting in same manner as previously described. Any engine, fitted with a .009 in. undersize crankshaft, will be identified by the following markings:

- ".009" will be stamped on crankshaft counterweight forward of center main journal.
- No. "9" will be stamped on block at left front oil pan rail.

IMPORTANT: If crankshaft has an undersize journal and a new bearing is required, journal must be reconditioned to accept a .010 or .020 in. undersize bearing as .009 in. undersize bearings are not available for service.

Inspection

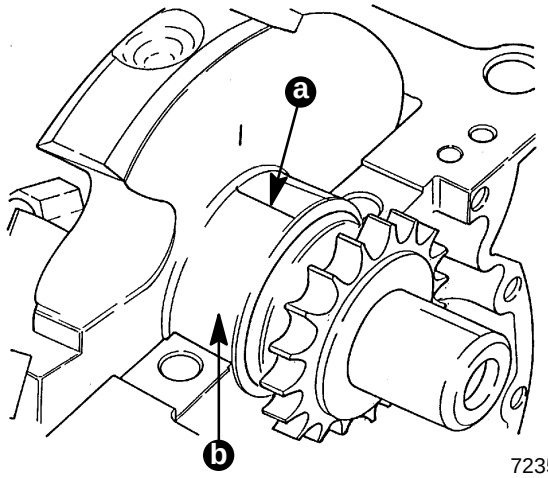
In general, the lower half of the bearing (except No. 1 bearing) shows a greater wear and the most distress from fatigue. If, upon inspection, the lower half is suitable for use, it can be assumed that the upper half is also satisfactory. If the lower half shows evidence of wear or damage, both upper and lower halves should be replaced. Never replace one half without replacing the other half.

Checking Clearances

To obtain accurate measurements while using Plastigage, or its equivalent, engine must be out of the boat and upside down so crankshaft will rest on the upper bearings and total clearance can be measured between lower bearing and journal.

To assure the proper seating of the crankshaft, all bearing cap bolts should be at their specified torque. In addition, preparatory to checking fit of bearings, the surface of the crankshaft journal and bearing should be wiped clean of oil.

1. With the oil pan and oil pump removed, remove bearing cap and wipe oil from journal and bearing cap to be inspected.
2. Place a piece of gauging plastic the full width of the bearing (parallel to the crankshaft) on the journal as shown.



72357

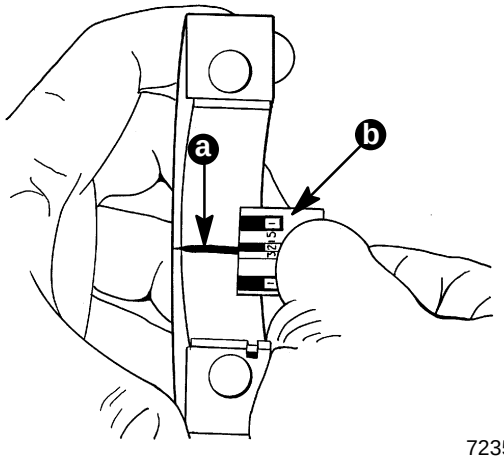
a - Gauging Plastic
b - Journal

3. Install the bearing cap and evenly torque the retaining bolts to specifications. Bearing cap MUST be torqued to specification in order to assure proper reading. Variations in torque affect the compression of the plastic gauge.

IMPORTANT: Do not rotate the crankshaft while the gauging plastic is between the bearing and journal.

4. Remove bearing cap. The flattened gauging plastic will be found adhering to either the bearing cap or journal.

5. On the edge of the gauging plastic envelope there is a graduated scale which is correlated in thousandths of an inch. Without removing the gauging plastic, measure its compressed width (at the widest point) with the graduations on the gauging plastic envelope as shown.



72358

a - Compressed Gauging Plastic
b - Graduated Scale

NOTE: *Normally main bearing journals wear evenly and are not out of round. However, if a bearing is being fitted to an out-of-round journal (.001 in. max.), be sure to fit to the maximum diameter of the journal: If the bearing is fitted to the minimum diameter, and the journal is out of round .001 in., interference between the bearing and journal will result in rapid bearing failure. If the flattened gauging plastic tapers toward the middle or ends, there is a difference in clearance indicating taper, low spot or other irregularity of the bearing or journal. Be sure to measure the journal with a micrometer if the flattened gauging plastic indicates more than .001 in. difference.*

6. If the bearing clearance is within specifications, the bearing insert is satisfactory. If the clearance is not within specifications, replace the insert. Always replace both upper and lower inserts as a unit.
7. A standard, or .001 in., undersize bearing may produce the proper clearance. If not, it will be necessary to regrind the crankshaft journal for use with the next undersize bearing.
8. After selecting new bearing, recheck clearance.
9. Proceed to the next bearing. After all bearings have been checked, rotate the crankshaft to see that there is no excessive drag. When checking No. 1 main bearing, loosen accessory drive belts so as to prevent tapered reading with plastic gauge.

Main Bearing Replacement

1. Remove and inspect crankshaft.
2. Remove main bearings from cylinder block and main bearing caps.
3. Coat bearing surfaces of new, correct-size, main bearing with oil and install in cylinder block and main bearing caps. Check clearance.
4. Install crankshaft.
5. Torque all main bearing caps, EXCEPT THE REAR MAIN CAP, to 75 lb. ft. (102 N·m). Torque rear main bearing cap to 10-12 lb. ft. (14-16 N·m); then tap end of crankshaft, first rearward then forward with a lead hammer. This will line up rear main bearing and crankshaft thrust surfaces. Torque rear main bearing cap to 75 lb. ft. (102 N·m).

Connecting Rod Bearings

Connecting rod bearings are of the precision insert type and do not use shims for adjustment. DO NOT FILE RODS OR ROD CAPS. If clearances are found to be excessive, a new bearing will be required. Service bearings are available in standard size and .001 in. and .002 in. undersize for use with new and used standard size crankshafts, and in .010 in. and .020 in. undersize for use with reconditioned crankshafts.

On removing a connecting rod cap, it is possible to find a .010 in. undersize bearing. These are used in manufacturing for selective fitting.

Inspection and Replacement

IMPORTANT: Before you remove the connecting rod cap, mark the side of the rod and cap with the cylinder number to assure matched reassembly of rod and cap.

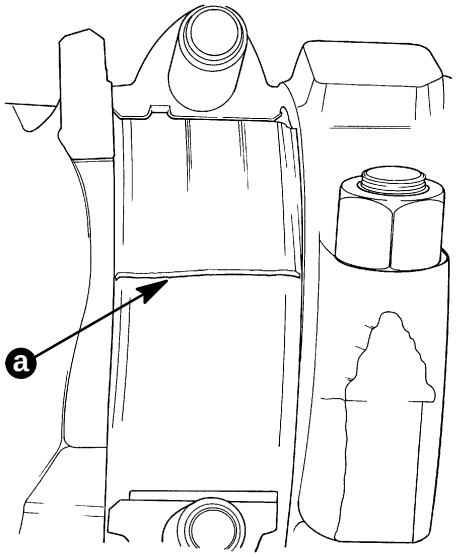
1. Remove connecting rod cap and bearing.
2. Inspect bearing for evidence of wear or damage. (Defective bearings should not be installed) Typical bearing failures are shown under ”General”.
3. Wipe bearings and crankshaft clean of oil.
4. Measure crankpin for out-of-round of taper with a micrometer. If not within specifications, replace or recondition crankshaft. If within specifications and new bearing is to be installed, measure maximum diameter of crankpin to determine new bearing size required.
5. If within specifications, measure new or used bearing clearances with Plastigage or equivalent.

IMPORTANT: If bearing is fitted to out-of-round crankpin, br sure to fit maximum diameter of crankpin. If bearing is fitted to minimum diameter, and crankpin is out-of-round .001 (0.025mm), interference between bearing and crankpin will result in rapid bearing failure.

a. Place a piece of guaging plastic the full width of crankpin (parallel to crankshaft).

b. Install bearing connecting rod and cap.

c. Place a piece of gauging plastic, the length of the bearing (parallel to the crankshaft), on the crankpin or bearing surface as shown. Position the gauging plastic in the middle of the bearing shell. (Bearings are eccentric and false readings could occur if placed elsewhere.)



72361

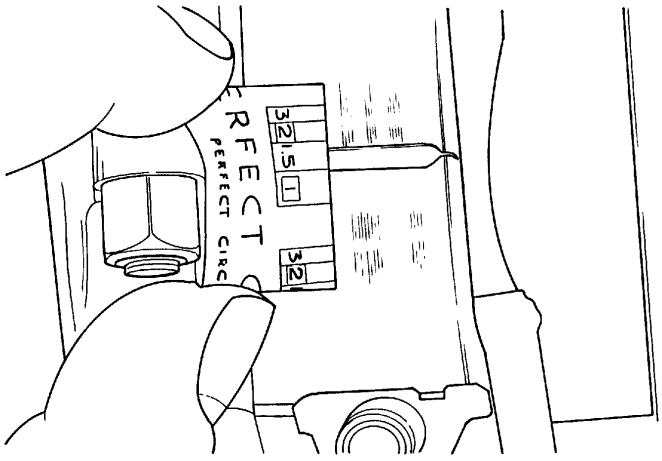
a - Gauging Plastic

d. Install the bearing in the connecting rod and cap.

e. Install the bearing cap and evenly torque nuts to 45 lb. ft. (61 N·m).

IMPORTANT: Do not turn the crankshaft with the gauging plastic installed.

f. Remove the bearing cap and using the scale on the gauging plastic envelope, measure the gauging plastic width at the widest point as shown.



72362

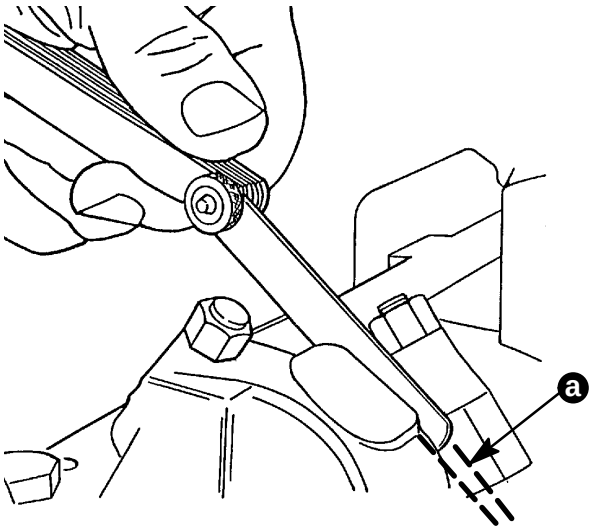
6. If the clearance exceeds specifications, select a new, correct size bearing and measure the clearance.

   Be sure to check what size bearing is being removed in order to determine proper replacement size bearing. If clearance cannot be brought to within specifications, the crankpin will have to be ground undersize. If the crankpin is already at maximum undersize, replace crankshaft.

7. Coat the bearing surface with oil, install the rod cap and torque nuts to 45 lb. ft. (61 N·m).

8. When all connecting rod bearings have been installed, tap each rod lightly (parallel to the crankpin) to make sure they have clearance.

9. Measure all connecting rod side clearances between connecting rod caps as shown - .006-.014 (0.152-0.356).



72891

a - Take Measurement Here

Connecting Rod/Piston Assembly

Removal

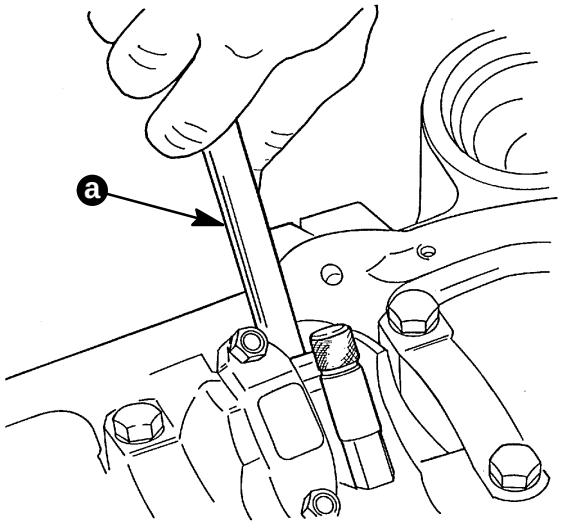
1. With oil, pan oil pump and cylinder head removed, use a ridge reamer to remove any ridge and/or deposits from upper end of cylinder bore

IMPORTANT: Before ridge and/or deposits are removed, turn crankshaft until piston is at bottom of stroke and place a cloth on top of piston to collect cuttings. After ridge and/or deposits are removed, turn crankshaft until piston is at top of stroke, then remove cloth and cuttings.

2. Inspect and mark connecting rods and bearing caps.

3. Remove connecting rod cap and install connecting rod bolt guide (3/8-24) on bolts. Push connecting rod and piston assembly out of top of cylinder block.

NOTE: *It will be necessary to turn crankshaft slightly to disconnect and remove some connecting rod and piston assemblies.*

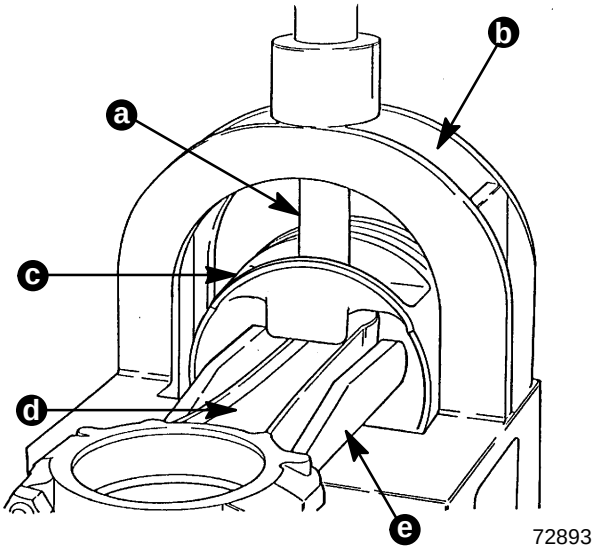


72892

a - Connecting Rod Bolt Guide (3/8-24) (J-5239)

Disassembly

1. Disassemble piston from connecting rod using piston pin remover as shown.



72893

a - Piston Pin Remover (J-24086-B)
b - Arched Base
c - Piston
d - Connecting Rod
e - Rod Support

2. Position connecting rod on tool rod support with rod support inserted between connecting rod end and piston. Align piston pin with hole located in top of arched base.
3. Insert pin remover thru hole (located in top of arched base) and into piston pin hole. Press on pin remover to remove piston pin.

Cleaning and Inspection

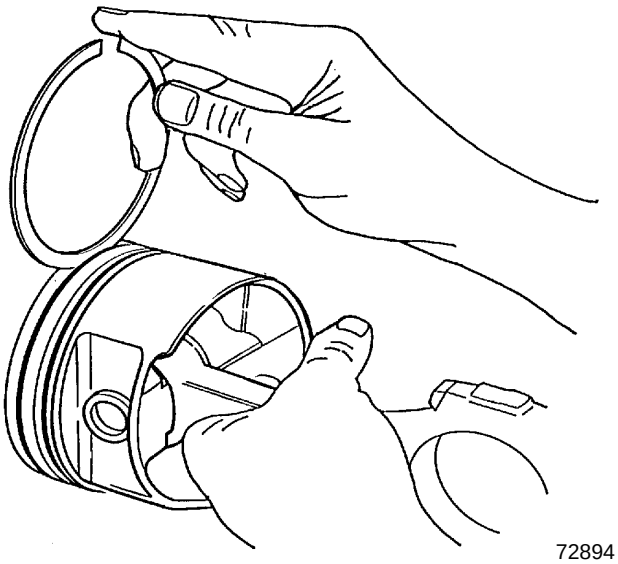
CONNECTING RODS

4. Wash connecting rods in cleaning solvent and dry with compressed air.
5. Check for twisted and bent rods and inspect for nicks and cracks. Replace damaged connecting rods.

PISTONS

NOTE: *Cylinder bore and taper must be within specifications before pistons can be considered for re-use.*

1. Clean varnish from piston skirts with a cleaning solvent. DO NOT WIRE BRUSH ANY PART OF PISTON. Clean ring grooves with a groove cleaner and make sure oil ring holes are clean.
2. Inspect piston for cracked ring lands, skirts and pin bosses, wavy worn ring lands, scuffed or damaged skirts, and eroded areas at top of piston. Replace pistons which are damaged or show signs of excessive wear.
3. Inspect grooves for nicks and burrs that might cause rings to hang up.
4. Measure piston skirt (across centerline of piston pin) and check clearance as outlined under “Cylinder Block”
5. Slip outer surface of a new top and second compression ring into respective piston ring groove and roll ring entirely around the groove to make sure that ring is free as shown. If binding occurs at any point, determine cause. If caused by ring groove, remove by dressing with a fine cut file. If binding is caused by a distorted ring, recheck with another ring.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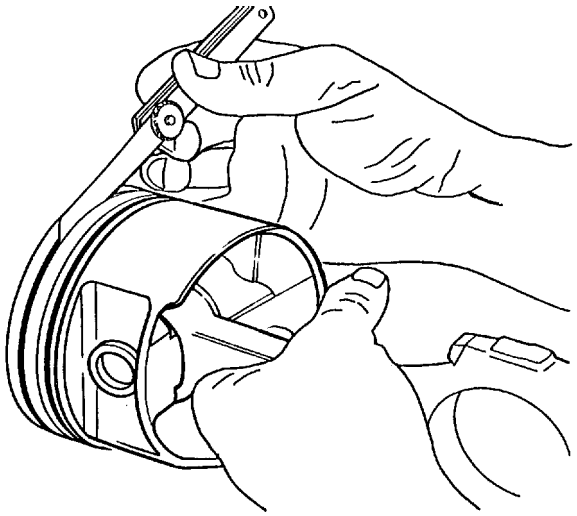
6. Proper clearance of piston ring in its piston ring groove is very important to provide proper ring action and reduce wear. Therefore, when fitting new rings, clearances between ring and groove surfaces should be measured. See “Specifications.”



72895

PISTON PINS

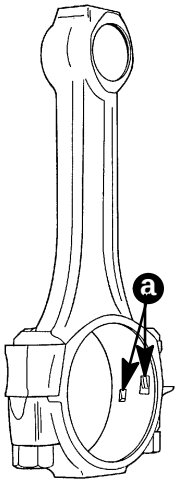
1. Piston pin clearance is designed to maintain adequate clearance under all engine operating conditions. Because of this, piston and piston pin are a matched set and not serviced separately.
2. Inspect piston pin bores and piston pins for wear. Piston pin bores and piston pins must be free of varnish and scuffing when measured. Measure piston pin with a micrometer and piston pin bore with a dial bore gauge or inside micrometer. If clearance is in excess of the .001 in. (0.025 mm) wear limit, replace piston and piston pin assembly.

Reassembly

PISTONS AND PISTON PINS

IMPORTANT: When reassembling pistons and connecting rods, the following must be kept in mind.

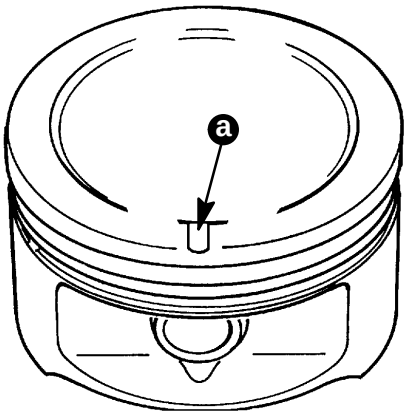
- **Piston and pin are machine fitted to each other and must remain together as a matched set. Do not intermix pistons and pins.**
- **If original pistons and/or connecting rods are being used, be sure to assemble pistons and connecting rods so they can be reinstalled in same cylinder from which they were removed.**
- **Connecting rod bearing tangs are always toward outside of cylinder block.**



72368

a - Rod Bearing Tangs

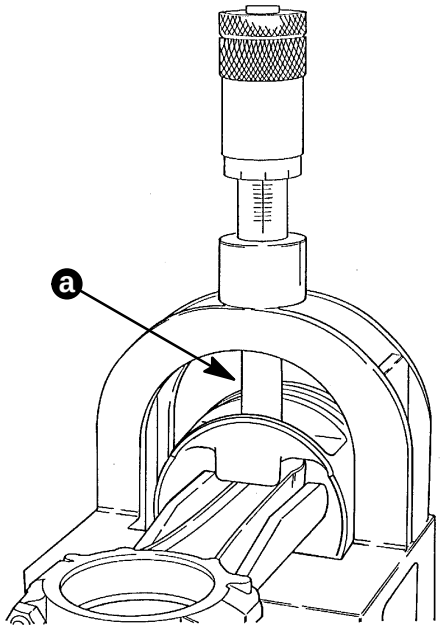
- **Notch on piston must be positioned toward the front of the engine.**



72896

a - Notch

1. Assemble piston to connecting rod using piston pin remover as shown. Follow instructions supplied with kit.



72897

a - Piston Pin Remover (J-24086-B)

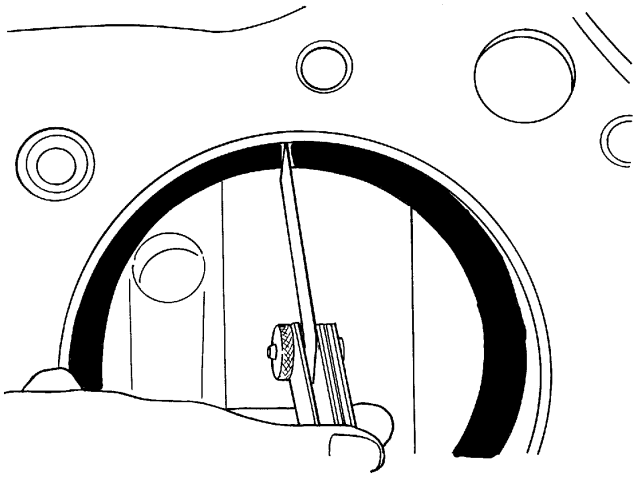
2. Once assembled, check piston for freedom of movement (back-and-forth and up-and-down) on connecting rod. Piston should move freely in all directions. If it does not, piston pin bore is tight and piston/pin assembly must be replaced.
3. If a new connecting rod has been installed, mark connecting rod and cap (on side of rod and cap with slots for connecting rod bearing tangs) with cylinder number in which it will be installed.

PISTON RINGS

All compression rings are marked on upper side of ring. When installing compression rings, make sure that marked side is toward top of piston. The top ring is treated with molybdenum for maximum life. Oil control rings are a three piece type, consisting of 2 segments (rails) and a spacer.

Oil control rings are a three-piece type, consisting of two rings and a spacer.

4. Select rings comparable in size to cylinder bore and piston size.
1. Slip compression ring in cylinder bore, then press ring down into cylinder bore about 1/4 in. (6 mm) (below ring travel). Be sure that ring is square with cylinder wall.
2. Measure gap between ends of ring with a feeler gauge as shown.



72372

3. If gap between ends of ring is below specifications, remove ring and try another for fit.
4. Fit each compression ring to cylinder in which it is going to be used.
5. Clean and inspect pistons, if not previously done.
6. Install piston rings as follows:
   a. Install oil ring spacer in groove and insert anti-rotation tang in oil hole.
   b. Hold spacer ends butted and install lower steel oil ring rail with gap properly located.
   c. Install upper steel oil ring rail with gap properly located.
   d. Flex the oil ring assembly to make sure ring is free. If binding occurs at any point, the cause should be determined and, if caused by ring groove, removed by dressing groove with a fine cut file. If binding is caused by a distorted ring, use a new ring.

IMPORTANT: Use piston ring expander (91-24697) for compression ring installation.

   e. Install lower compression ring with marked side up, using ring expander.

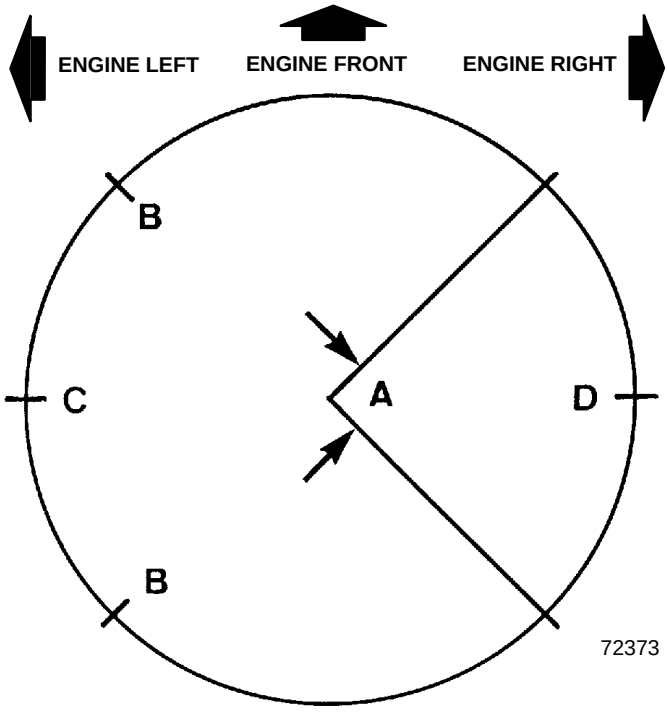
f. Install top compression ring with marked side up, using ring expander.

Installation

IMPORTANT: Cylinder bores must be clean before piston installation. Clean with a light honing, as necessary. Then clean with hot water and detergent wash. After cleaning, swab bores several times with light engine oil and clean cloth, then wipe with a clean dry cloth.

1. Lubricate connecting rod bearings and install in rods and rod caps.
2. Lightly coat pistons, rings and cylinder walls with light engine oil.
3. With bearing caps removed, install connecting rod bolt guide (3/8-24) (J-5239) on connecting rod bolts.

IMPORTANT: Be sure ring gaps are properly positioned as shown.

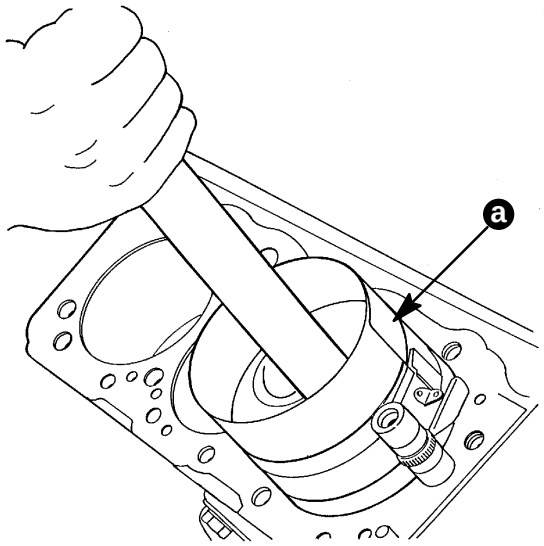


A - Oil Ring Spacer Gap (Tang in Hole or Slot within Arc)
B - Oil Ring Rail Gaps
C - 2nd Compression Ring Gap
D - Top Compression Ring Gap

Ring Gap Location

4. Install each connecting rod and piston assembly in its respective bore. Install with connecting rod bearing tangs toward outside of cylinder block. Use piston ring compressor to compress rings. Guide connecting rod into place on crankshaft journal with connecting rod bolt guide. Use a hammer handle with light blows to install piston into bore. Hold ring compressor firmly against cylinder block until all piston rings have entered cylinder bore.

IMPORTANT: Be sure to install new pistons in same cylinders for which they were fitted, and used pistons in same cylinder from which they were removed. Each connecting rod and bearing cap should be marked, beginning at front of engine. Numbers on connecting rod and bearing cap must be on same side when installed in cylinder bore. If a connecting rod is ever transposed from one block or cylinder to another, new bearings should be fitted and connecting rod should be numbered to correspond with new cylinder number.



a - Piston Ring Compressor (J-8037)

5. Remove connecting rod bolt guide.
6. Install bearing caps and torque nuts to 20 lb. ft. (27 N·m), then tighten nuts an additional 60 degrees angular torque using a Torque Angle Gauge.
7. Check connecting rod side clearance as previously described.

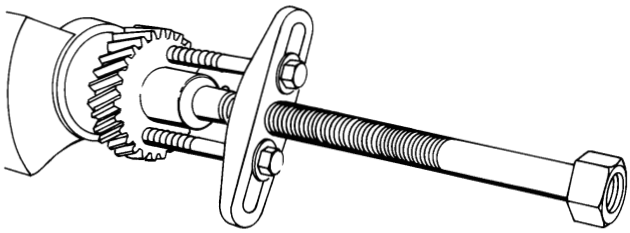
NOTE: *If bearing replacement is required, refer to "Connecting Rod Bearings."*

8. Install as previously outlined:
   a. Oil pump.
   b. Dipstick and oil pan.
   c. Cylinder heads.
   d. Intake manifold.
   e. Distributor.
9. Fill crankcase with oil. Refer to SECTION 1 - “Maintenance.”
10. Torque rocker arm nuts to 20 lb. ft. (27 N·m).

Crankshaft

Removal

1. Remove engine from boat.
2. Drain crankcase oil.
3. Remove as outlined:
   a. Starter.
   b. Flywheel housing.
   c. Drive coupler and flywheel.
   d. Belts.
   e. Water pump.
   f. Crankshaft pulley and torsional damper.
   g. Spark plugs.
   h. Oil pan and dipstick tube.
   i. Oil pump.
   j. Timing chain cover.
4. Turn crankshaft to align timing mark with camshaft mark.
5. Remove camshaft sprocket.
6. Remove rear main seal and retainer.
7. Ensure all bearing caps (main and connecting rods) are marked so they can be reinstalled in their original locations.
8. Remove connecting rod bearing caps, then push piston and rod assemblies toward heads.
9. Remove main bearing caps and carefully lift crankshaft out of cylinder block.
10. Remove crankshaft gear as shown.



74476

11. If new main and/or connecting rod bearings are to be installed, remove main bearing inserts from cylinder block and bearing caps, and/or connecting rod bearing inserts from connecting rod and caps. Install new bearings following procedures outlined.

Cleaning and Inspection

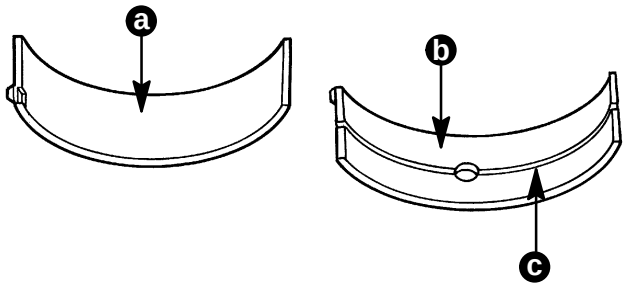
1. Wash crankshaft in solvent and dry with compressed air.
2. Measure main bearing journals and crankpin dimensions with a micrometer for out-of-round, taper or undersize (see “Specifications”).
3. Check crankshaft for runout (by supporting at front and rear main bearings journals in V-blocks) and check at front and rear intermediate journals with a dial indicator (see “Specifications”).
4. Replace or recondition crankshaft if not within specifications.

Installation

1. If a new crankshaft is being installed, remove timing sprocket from old crankshaft and reinstall on new crankshaft as outlined.

IMPORTANT: Be sure that all bearings and crankshaft journals are clean.

2. Install main bearings in engine block as shown.



72359

a - Lower Bearing Insert
b - Upper Bearing Insert
c - Oil Groove

Main Bearing Inserts

1. Carefully lower crankshaft into place. Be careful not to damage bearing surface.
2. Check clearance of each main bearing, following procedure outlined under “Main Bearings.” If bearing clearances are satisfactory, apply engine oil to journals and bearings.
3. Install main bearing caps. Torque bolts to 75 lb. ft. (102 N·m). When tightening rear main bearing cap, follow procedure outlined under “Main Bearings.”
4. Check crankshaft end play as previously outlined.
5. Install rear main seal retainer and seal. Torque fasteners to 133 lb. in. (15 N·m).
6. Check clearance for each connecting rod bearing, following procedure under “Connecting Rod Bearings.” If bearing clearances are satisfactory, apply engine oil to journals and bearings.
7. Install rod caps and torque nuts to 45 lb. ft. (61 N·m).
8. Turn crankshaft so mark on timing sprocket is facing camshaft.
9. Install as outlined:
   a. Timing chain and sprocket on camshaft - align marks with crankshaft.
   b. Timing chain cover.
   c. Oil pump.
   d. Dipstick tube and oil pan.
   e. Spark plugs.
   f. Torsional damper and crankshaft pulley.
   g. Water pump.
   h. Belts.
   i. Flywheel and drive coupler.
   j. Flywheel housing.
   k. Starter.
10. Install new oil filter. Fill crankcase with oil.

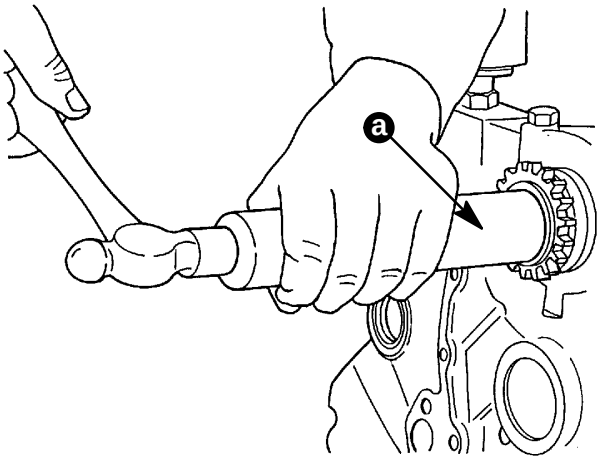
Crankshaft Sprocket

Removal

1. Remove torsional damper and crankcase front cover as previously outlined.
2. Remove camshaft timing chain as outlined, and using crankshaft gear and sprocket puller (J-5825-A), remove crankshaft sprocket.

Installation

1. Using crankshaft gear and sprocket installer, as shown, install sprocket on crankshaft.



72377

a - Crankshaft Gear and Sprocket Installer (J-5590)

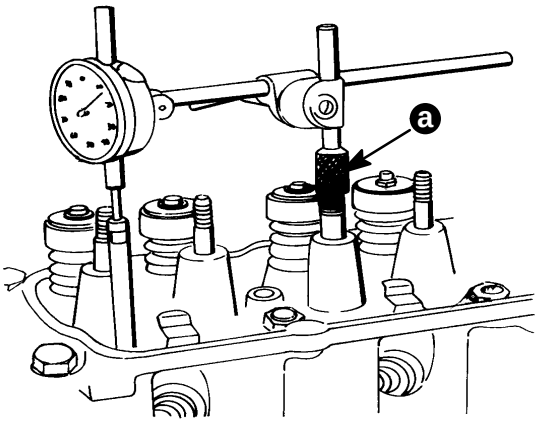
2. Install timing chain as outlined.
3. Install crankcase cover and torsional damper as outlined.

Camshaft

Measuring Lobe Lift

NOTE: *Procedure is similar to checking valve timing. If improper valve operation is indicated, measure lift of each push rod in consecutive order and record readings.*

4. Remove valve mechanism as previously outlined.
5. Position indicator with ball socket adaptor tool on push rod. Be sure that push rod is in lifter socket.



72907

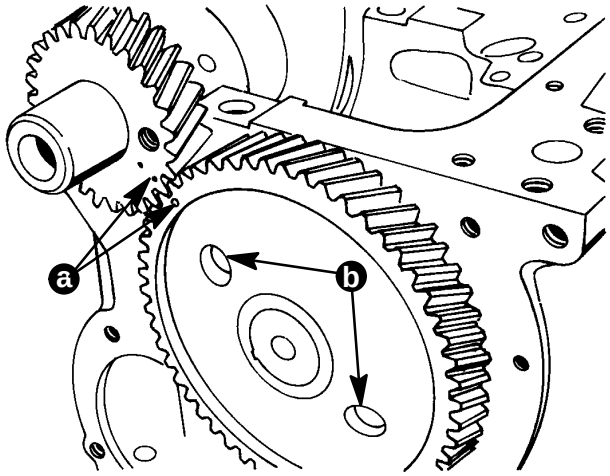
a - Ball Socket Adaptor Tool (J-8520-1)

6. Rotate crankshaft torsional damper slowly in direction of rotation until lifter is on heel of cam lobe. At this point, push rod will be in its lowest position.
7. Set dial indicator on zero, then rotate balancer slowly (or attach an auxiliary starter switch and “bump” engine over) until push rod is in fully raised position.
8. Compare total lift, recorded from dial indicator, with “Specifications.”
9. Continue to rotate engine until indicator reads zero. This will be a check on accuracy of original indicator reading.
10. If camshaft readings for all lobes are within specifications, remove dial indicator assembly.
11. Install rocker arm and push rod. Torque nuts to 20 lb. ft. (27 N·m).

Removal

1. Remove valve lifters as previously outlined.
2. Remove crankcase front cover as previously outlined.
3. Remove fuel pump.
4. Align timing gear marks, then remove the two camshaft thrust plate screws by working thru holes in camshaft gear.
5. Pull camshaft and gear assembly out thru front of block.

IMPORTANT: Support camshaft carefully when removing to protect camshaft bearings.

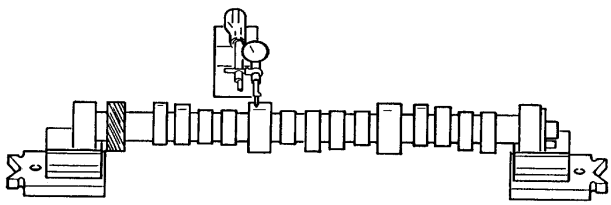


74438

a - Timing Marks
b - Screw Access Holes

Inspection

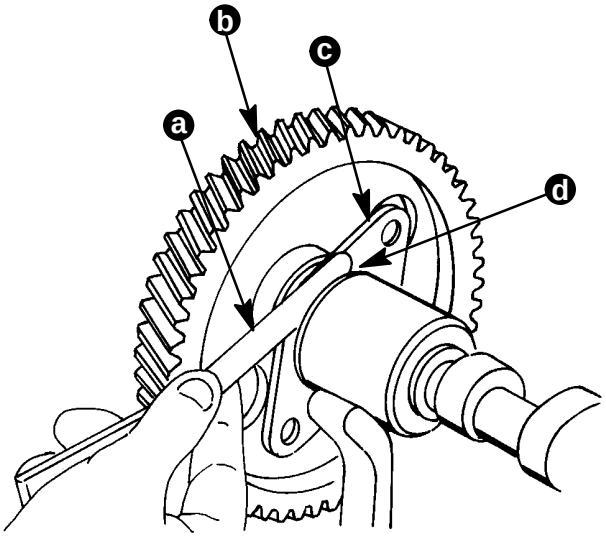
1. Measure camshaft bearing journals with a micrometer for out-of-round condition. If journals exceed .001 in. (0.025 mm) out-of-round, camshaft should be replaced.
2. Also check camshaft for alignment with V-blocks and dial indicator which indicates exact amount camshaft is out of true. If dial indicator reads more than .002 in. (0.051 mm) camshaft should be replaced.



72909

Checking Camshaft Alignment

3. Inspect camshaft gear and thrust plate for wear or damage. Measure camshaft end play .001 - .005 in. (0.03-0.1 mm)



74439

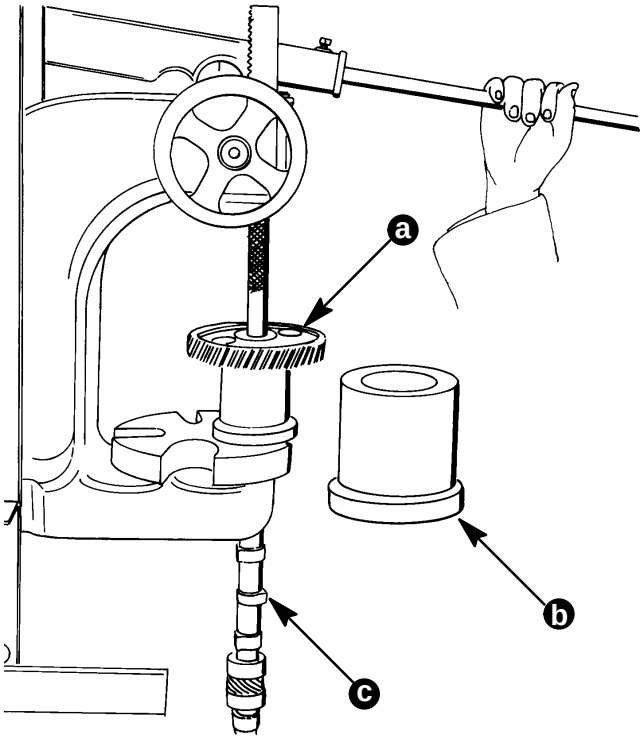
a - Feeler Gauge
b - Camshaft Gear
c - Camshaft Thrust Plate
d - Take Measurement Here

Camshaft Gear Replacement

1. If inspection indicates that camshaft, gear or thrust plate should be replaced, remove gear from camshaft.
2. Place camshaft thru gear remover, place end of remover on table of a press shaft out of gear.

⚠CAUTION

Position thrust plate so that woodruff key in shaft does not damage plate when shaft is pressed out of gear. Also support hub of gear, or gear will be seriously damaged.

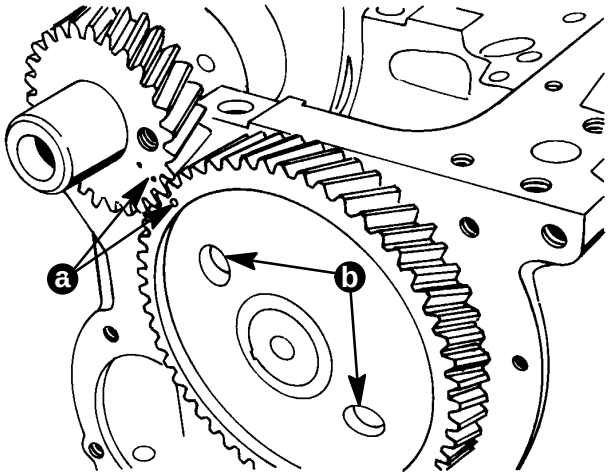


74477

a - Camshaft Gear
b - Support Sleeve
c - Camshaft

Installation

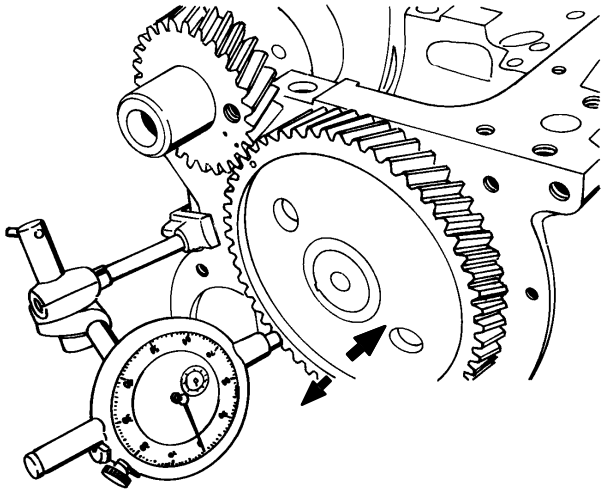
1. Install camshaft and gear assembly in engine block, being careful not to damage camshaft bearings or camshaft.



74438

a - Timing Marks
b - Screw Access Holes

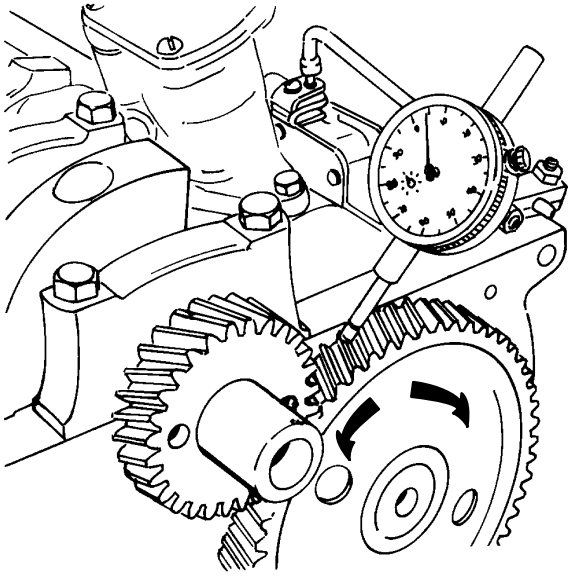
2. Turn crankshaft and camshaft so the timing marks on gear teeth will line up. Push camshaft thrust plate to block screws and torque to specifications.
3. Check camshaft and crankshaft gear run-out with a dial indicator. Camshaft gear run-out should not exceed .004 in. (0.1 mm) and crankshaft gear run-out should not exceed .003 in. (0.07 mm).



74440

Checking Timing Gear Run-Out

4. If gear run-out is excessive, remove gear and clean burrs from shaft, or gear must be replaced.
5. Check backlash between timing gear teeth with a dial indicator. Backlash should not be less than .004 in. (0.010 mm) or more than .006 in. (0.15 mm)



74441

Checking Timing Gear Backlash

6. Install fuel pump.
7. Install front crankcase cover.
8. Pour G. M. Engine Oil supplement or light engine oil over camshaft lobes and install valve lifters.

Index

Camshaft Bearings

Removal

Camshaft bearings can be replaced while engine is disassembled for overhaul or without complete disassembly. To replace bearings without complete disassembly, remove camshaft and crankshaft, leaving cylinder heads attached and pistons in place. Before removing crankshaft, fasten connecting rods against sides of engine so that they will not interfere while replacing camshaft bearings.

9. With camshaft and crankshaft removed, drive camshaft rear plug from cylinder block.

NOTE: *This procedure is based on removal of bearings from center of engine first, thus requiring a minimum amount of turns to remove all bearings.*

1. Using camshaft bearing remover and installer set (J-6098-01) (with nut and thrust washer installed to end of threads), position pilot in front camshaft bearing and install puller screw through pilot.
2. Install tool with shoulder toward bearing. Be sure a sufficient amount of threads are engaged.
3. Using two wrenches, hold puller screw while turning nut. When bearing has been pulled from bore, remove tool and bearing from puller screw.
4. Remove remaining bearings (except front and rear) in same manner. It will be necessary to position pilot in rear camshaft bearing to remove rear intermediate bearing.
5. Assemble driver on driver handle and remove front and rear camshaft bearings by driving toward center of cylinder block.

Inspection

Clean camshaft bearing bores in cylinder block with solvent and blow out with compressed air. Be sure grooves and drilled oil passages are clean.

Installation

⚠CAUTION

Oil holes in bearings must line up with oil holes in cylinder block. Oil hole is on top side of bearing shell and cannot be seen during installation, so first align bearing shell oil hole with oil hole in bore and mark opposite side of bearing and block at bore to easily position oil hole during installation.

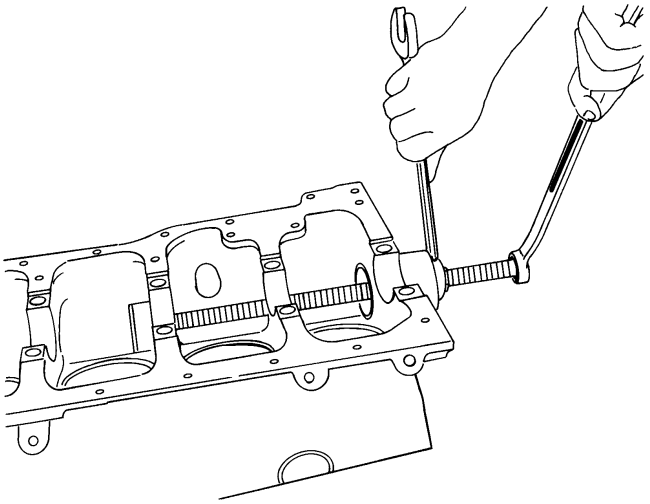
IMPORTANT: Front bearing must be driven approximately .125 in. (3 mm) behind the block face to uncover oil hole to timing gear oil nozzle.

IMPORTANT: All camshaft bearings are not the same. Be sure to install bearings in proper locations (Indicated by bearing manufacturer) and to position bearings as follows (directional references are in reference to engine in its normal operating position):

Lubricate outer surface of new camshaft bearings with engine oil to ease installation.

1. Installing intermediate and center bearings:
   a. Install nut and thrust washer all the way onto puller screw, then position pilot in front camshaft bearing bore and insert screw through pilot.

b. Index center camshaft bearing, then position appropriate size remover and installer tool in bearing and thread puller screw into tool. Be sure at least 1/2 in. (13 mm) of threads are engaged.



74478

Pulling Cam Bearing From Bore

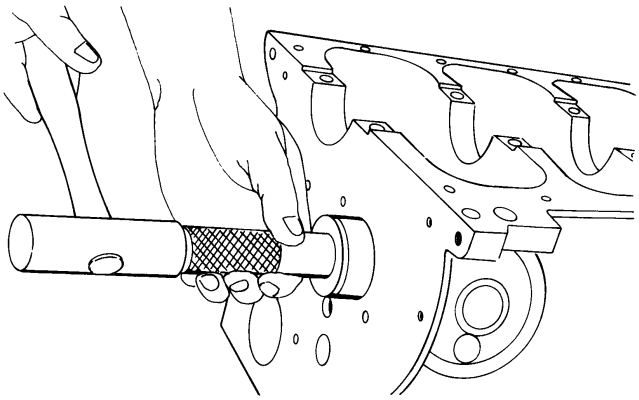
c. Using two wrenches, hold puller screw and turn nut until bearing has been pulled into position. Remove the remover and installer tool and check to ensure that oil hole(s) in bearing are positioned correctly.

d. Install intermediate bearings in same manner being sure to index bearings correctly. It will be necessary to position pilot in rear camshaft bearing bore to install rear intermediate bearing.

2. Installing front and rear bearings:

   a. Install appropriate size remover and installer tool on drive handle.

   b. Index front bearing (as explained in “Important” above), and drive it into position with tool. Check position of oil hole(s) in bearing to ensure bearing is positioned correctly.



74479

Removal And Installation Camshaft Bearings

a - Installation Tool
b - Camshaft Bearing

   c. Install rear bearing in same manner, being sure to index bearing correctly.

3. Install a new camshaft rear plug.

IMPORTANT: Plug must be installed flush to 1/32 in. (0.8 mm) deep and must be parallel with rear surface of cylinder block.

4. Install crankshaft and camshaft as previously outlined.

Cylinder Block

Cleaning and Inspection

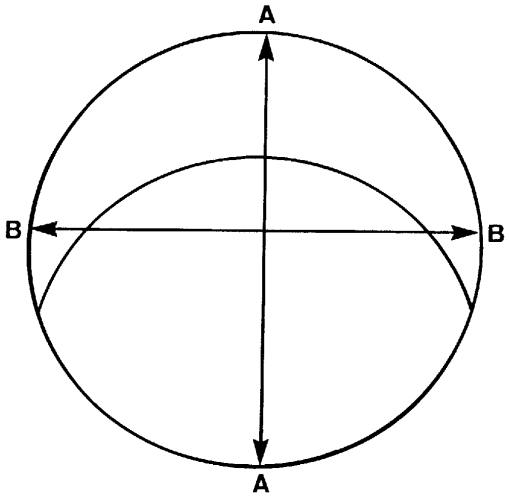
1. Remove all engine components as previously outlined.
2. Wash cylinder block thoroughly in cleaning solvent and clean all gasket surfaces.
3. Remove oil gallery plugs and clean all oil passages.
4. Remove expansion plugs.

NOTE: *These plugs may be removed with a sharp punch, or they may be drilled and pried out.*

5. Clean and inspect water passages in cylinder block.
6. Inspect cylinder block for cracks in cylinder walls, water jacket valve lifter bores and main bearing webs.

⚠CAUTION

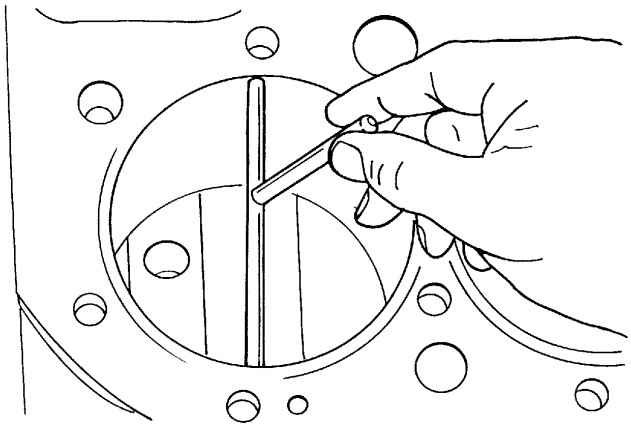
Measure cylinder walls for taper, out-of-round or excessive ridge at top of ring travel. This should be done with a dial indicator or inside micrometer. Carefully work gauge up and down cylinder to determine taper and turn it to different points around cylinder wall to determine out-of-round condition. If cylinders exceed specifications, boring and/or honing will be necessary.



72385

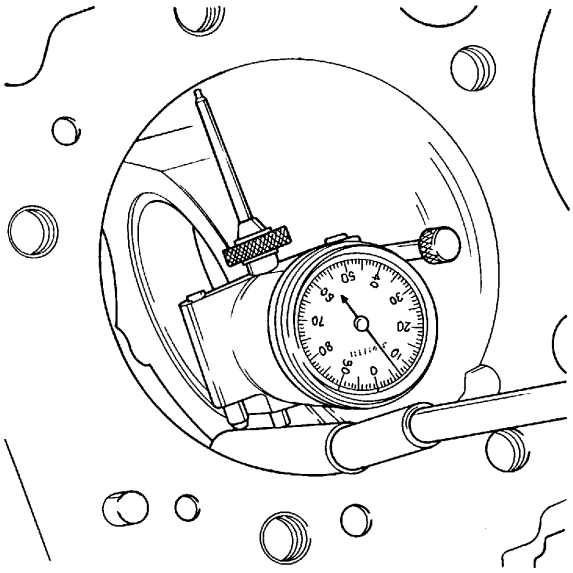
"A" = At right angle to centerline of engine
"B" = Parallel to centerline of engine
"Out-of-Round" = Difference between "A" and "B"
"Taper" =Difference between measurement "A" at top of cylinder bore and "A" measurement at bottom of cylinder bore

Cylinder Measurement



72386

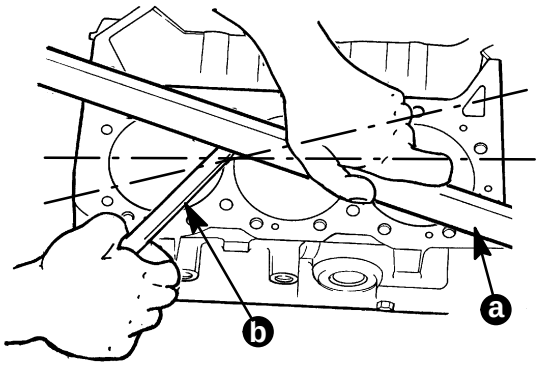
Measuring Cylinder Bore With Snap Gauge



72387

Measuring Cylinder Bore With Dial Indicator

7. Check cylinder head gasket surfaces for warpage with a machinist's straight-edge and a feeler gauge, as shown. Take measurements diagonally across surfaces (both ways) and straight down center. If surfaces are warped more than .003 in. (0.07 mm) in a 6 in. area or .007 in. (0.2 mm) overall, block must be resurfaced by an automotive machine shop.



72910

a - Machinist's Straight-Edge
b - Feeler Gauge

CYLINDER CONDITIONING

1. Performance of the following operation depends upon engine condition at time of repair.
2. If cylinder block inspection indicates that block is suitable for continued use (except for out-of-round or tapered cylinders), they can be conditioned by honing or boring.
3. If cylinders have less than .005 in. (0.127 mm) taper or wear, they can be conditioned with a hone and fitted with high limit standard size piston. A cylinder bore of more than .005 in. wear or taper may not clean up entirely when fitted to a high limit piston. To entirely clean up the bore, it will be necessary to bore for an oversize piston. If more than .005 in. taper or wear, bore and hone to smallest oversize that will permit complete resurfacing of all cylinders.
4. When pistons are being fitted and honing is not necessary, cylinder bores may be cleaned with a hot water and detergent wash. After cleaning, swab cylinder bores several times with light engine oil and a clean cloth, then wipe with a clean dry cloth.

CYLINDER BORING

1. Before using any type boring bar, file off top of cylinder block to remove dirt or burrs. This is very important to prevent boring bar tilt, with result that bored cylinder wall is not at right angles to crankshaft.
2. Measure piston to be fitted with a micrometer, measuring at center of piston skirt and at right angles to piston pin. Bore cylinder to same diameter as piston and hone to give specified clearance.

NOTE: *Hone cylinders as outlined under "Cylinder Honing" and "Piston Selection," following.*

3. Carefully observe instructions furnished by manufacturer of equipment being used.

CYLINDER HONING

1. Follow hone manufacturer's recommendations for use of hone and cleaning and lubrication during honing.
2. Occasionally, during the honing operation, thoroughly clean cylinder bore and check piston for correct fit in cylinder.
3. When finish-honing a cylinder bore to fit a piston, move hone up and down at a sufficient speed to obtain very fine uniform surface finish marks in a crosshatch pattern of approximately 30 degrees to cylinder bore. Finish marks should be clean but not sharp, free from imbedded particles and torn or folded metal.

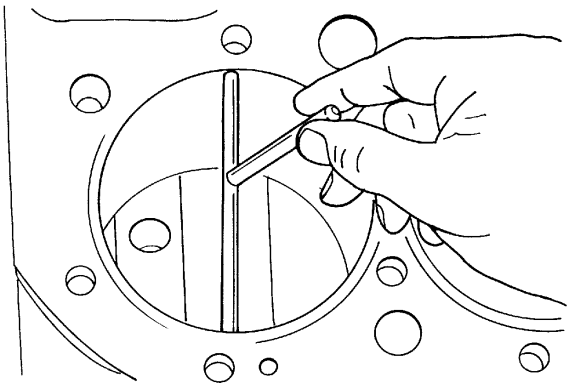
4. Permanently mark piston (for cylinder to which it has been fitted) and proceed to hone cylinders and fit remaining pistons.

IMPORTANT: Handle pistons with care and do not attempt to force them through cylinder until cylinder is honed to correct size, as this type piston can be distorted by careless handling.

5. Thoroughly clean cylinder bores with hot water and detergent. Scrub well with a stiff bristle brush and rinse thoroughly with hot water. It is extremely essential that a good cleaning operation be performed. If any abrasive material remains in cylinder bores, it will rapidly wear new rings and cylinder bores in addition to bearings lubricated by the contaminated oil. Swab bores several times with light engine oil on a clean cloth, then wipe with a clean dry cloth. Cylinder should not be cleaned with kerosene or gasoline. Clean remainder of cylinder block to remove excess material spread during honing operation.

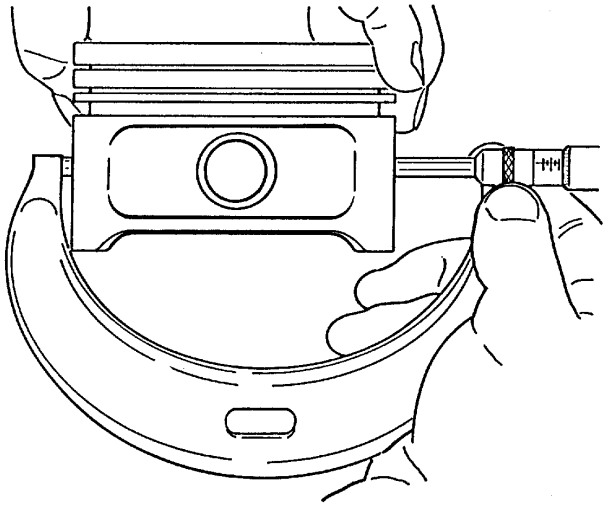
PISTON SELECTION

1. Check used piston to cylinder bore clearance as follows:
   a. Measure cylinder bore diameter with a telescope gauge 2-1/2 in. (64 mm) from top of cylinder bore as follows.



72386

   b. Measure piston diameter at skirt across center line of piston pin as shown.



72911

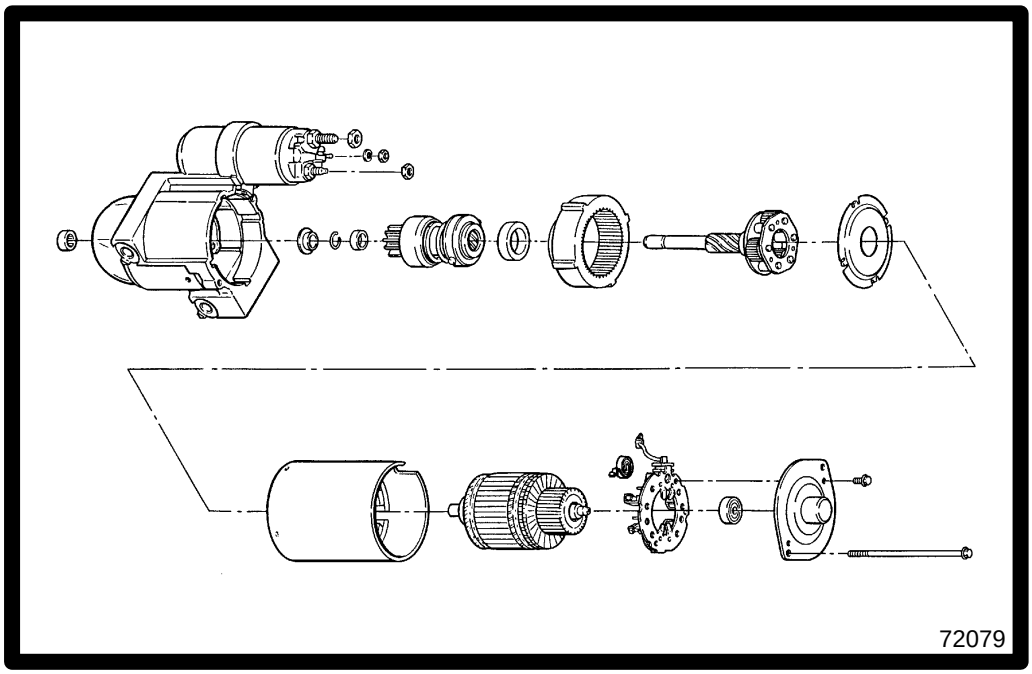
   c. Subtract piston diameter from cylinder bore diameter to determine piston-to-bore clearance.
   d. Determine if piston-to-bore clearance is in acceptable range shown in “Specifications.”
2. If used piston is not satisfactory, determine if a new piston can be selected to fit cylinder bore within acceptable range.
3. If cylinder bore must be reconditioned, measure new piston diameter (across centerline of piston pin), then hone cylinder bore to correct clearance (preferable range).
4. Mark piston to identify cylinder for which it was fitted.

Oil Filter By-Pass Valve

Inspection and/or Replacement

With oil filter removed, check spring and fiber valve for operation. Inspect for a cracked or broken valve. If replacement is necessary, pry valve out with screwdriver. Install and seat a new valve by tapping in place with a 9/16 in. thin wall deep socket.

ELECTRICAL SYSTEMS



4

A

STARTING SYSTEM

Index

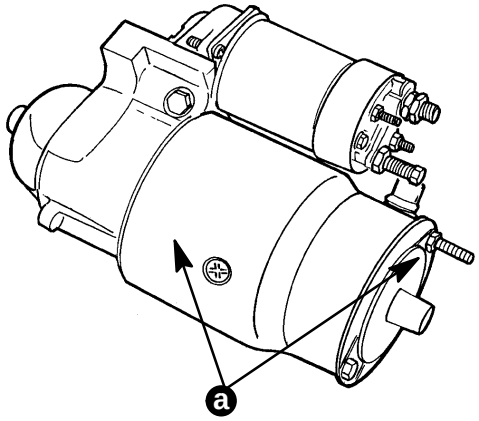
Table of Contents

	Page
Identification	4A - 1
Important Information	4A - 1
Replacement Parts Warning	4A - 2
Battery	4A - 2
Battery Cable Recommendations	4A - 2
Precautions	4A - 2
Testing	4A - 3
Load Test	4A - 3
Hydrometer Test	4A - 3
Storage	4A - 4
Charging Guide	4A - 5
12 Volt Battery Recommended Rate* and Time for Fully Discharged Condition	4A - 5
Slave Solenoid Identification	4A - 6
Types	4A - 6
Standard Type Slave Solenoid	4A - 6
Switch Type Slave Solenoid	4A - 6
Testing/Replacement	4A - 7
Specifications	4A - 8
Torque Specifications	4A - 8
Lubricants/Sealants	4A - 8
Starter Motor (Exploded View)	4A - 9
Starting System Components	4A - 10
Positive Current Flow	4A - 10
Periodic Inspection	4A - 11
Starter Motor Repair	4A - 11
Removal	4A - 11
Solenoid Switch	4A - 12
Starter Motor Disassembly	4A - 13
Cleaning and Inspection	4A - 14
Armature Tests	4A - 14
Field Coil Tests	4A - 15
Loose Electrical Connections	4A - 15
Turning the Commutator	4A - 15
Reassembly	4A - 16
Clearances	4A - 17
Installation	4A - 18
Delco PG200 and PG260 Starters	4A - 18
Description	4A - 18
PG200 Specifications	4A - 19
PG260 Specifications	4A - 19
Torque Specification	4A - 19
Starting System Components	4A - 20
PG200 Exploded View	4A - 21
PG260 Exploded View	4A - 22
Solenoid Switch	4A - 23
Periodic Inspection	4A - 23
Starter Motor Repair	4A - 23
Removal	4A - 23
PG200 Disassembly	4A - 23
Cleaning and Inspection	4A - 25
Armature Tests	4A - 25
Armature Bearing (Commutator End)	4A - 26
Gear Bearing	4A - 26
Shaft Assembly Bearing	4A - 27
Drive End Housing Bearing	4A - 27
Brushes and Brush Holder	4A - 27
PG200 Reassembly	4A - 28
Standard Starter Slave Solenoid	4A - 30
Testing/Replacement	4A - 30
Installation	4A - 31

Index

Identification

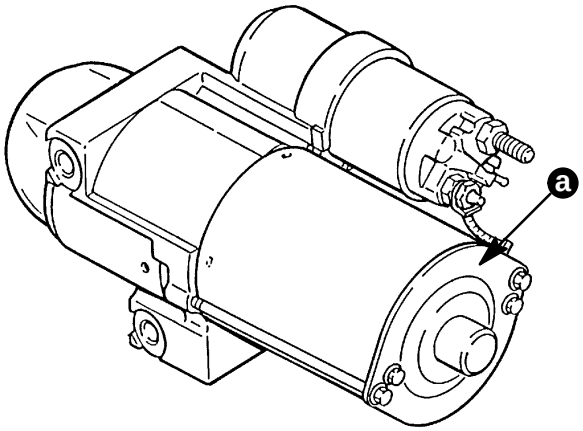
The starter identification number is located as shown.



72789

a - Delco Number

Delco-Remy Starter Motor 50-99417A––



72059

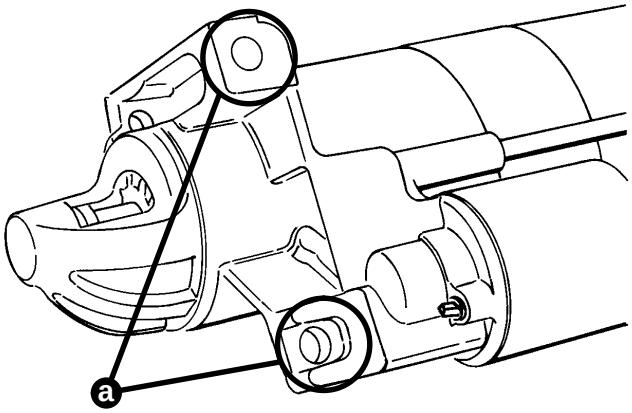
a - Starter Identification Number

Delco PG 200 Starter Motor 50-812429A––
50-812604A––

Important Information

If the PG 200 or PG 260 starter has not been removed, it is recommended that it be removed and inspected as follows:

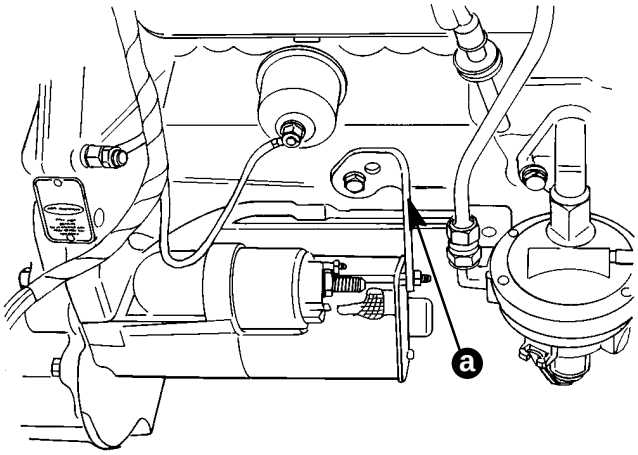
1. Disconnect battery cables from battery.
2. Disconnect wiring from starter. Remove starter.
3. Inspect starter motor drive housing, replace if necessary.



74517

a - Inspect This Area For Cracks

STARTER BRACKET



74523

a - Starter Bracket (If So Equipped)

Index

Replacement Parts Warning

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

⚠WARNING

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Battery

Battery Cold Cranking Amperage	
3.0L/3.0LX	375 cca, 475 mca, 90Ah

Battery Cable Recommendations

IMPORTANT: Terminals must be soldered to cable ends to ensure good electrical contact. Use electrical grade (resin flux) solder only. Do not use acid flux solder, as it may cause corrosion and failure.

Cable Length	Cable Gauge
Up to 3-1/2 Ft. (1.1 m)	4 (25 mm^2)
3-1/2 - 6 Ft (1.1-1.8 m)	2 (35 mm^2)
6 - 7-1/2 Ft. (1.8-2.3 m)	1 (50 mm^2)
7-1/2 - 9-1/2 Ft. (2.3-2.9 m)	0 (50 mm^2)
9-1/2 - 12 Ft. (2.9-3.7 m)	00 (70 mm^2)
12 - 15 Ft. (3.7-4.6 m)	000 (95 mm^2)
15 - 19 Ft. (4.6-5.8 m)	0000 (120 mm^2)
Both positive (+) and negative (–) cables	

Precautions

⚠WARNING

Hydrogen gases that escape from the battery during charging are explosive. Be sure that battery area is well ventilated and that bilge blower is in operation when charging. DO NOT smoke or allow sources of spark or open flame in area when charging battery.

⚠WARNING

Do not use jumper cables and a booster battery to start engine. Do not recharge a weak battery in the boat. Remove battery and recharge in a ventilated area away from fuel vapors, sparks or flames.

⚠WARNING

Battery electrolyte is a corrosive acid and should be handled with extreme care. If electrolyte are spilled or splashed on any part of the body, IMMEDIATELY flush the exposed area with liberal amounts of water and obtain medical aid as soon as possible. Safety glasses and rubber gloves are recommended when handling batteries.

⚠CAUTION

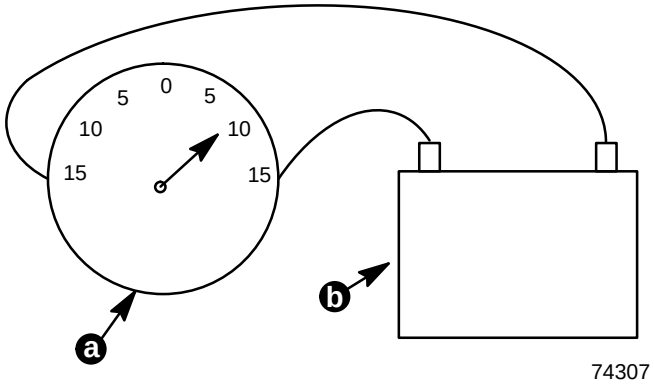
To prevent damage to the electrical system be sure to adhere to the following:

- **When installing battery, be sure to connect the POSITIVE (+) battery cable to POSITIVE (+) battery terminal first and then the NEGATIVE (–) battery cable to NEGATIVE (–) battery terminal.**
- **Never disconnect the battery cables while the engine is running.**
- **If a charger or booster is to be used, be sure to connect it in parallel with existing battery (positive to positive and negative to negative).**
- **When applying a booster charge to battery, disconnect both cables from battery (to prevent damage to voltage regulator).**
- **Check battery condition periodically.**
- **Make sure that battery leads are kept clean and tight.**

Testing

Load Test

A strong battery must be maintained. If battery shows less than 9-1/2 volts when under starting load,(at 80° F 27° C)it should be recharged. Check with DC voltmeter.



a - Voltmeter
b - Battery

Place battery under heavy load (as during engine cranking or with a variable resistor tester) and test cell voltage while under load.

Certain conditions must be met before testing.

- Battery must be 60 to 100°F (16 to 38°C).
- Electrolyte level must be correct in all cells.
- Battery must be at least half charged.
- No obvious defects.

4. Check voltage per manufacturer's specifications.
5. If readings are low, recharge and retest.
6. If readings remain low, battery should be replaced.

Hydrometer Test

⚠ WARNING

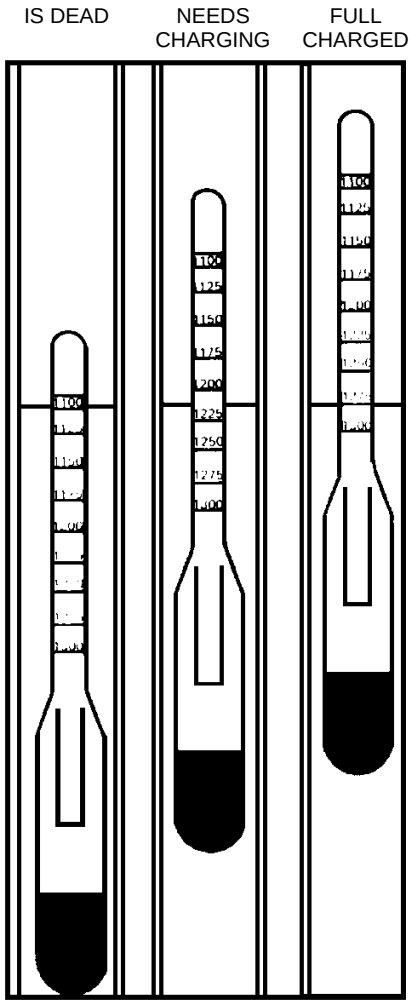
Test battery in well ventilated area as gases given off by battery are hazardous.

1. Hydrometer must be clean (inside and out) to insure an accurate reading.
2. Never take hydrometer readings immediately after water has been added.
3. If hydrometer ha a thermometer, draw liquid in several times to ensure correct temperature before before taking reading.
4. Hold hydrometer vertically and draw in just enough liquid from battery cell so that float is free-floating. Hold hydrometer at eye level so that float is vertical and free of outer tube, then take reading at surface of liquid.
5. Avoid dropping electrolyte on boat or clothing, as it is extremely corrosive. Wash off immediately with baking soda solution.

Index

HYDROMETER READINGS

BATTERIES TESTED BELOW



FULLY CHARGED	1.280 - 1.260
75% CHARGED	1.230 - 1.220
50% CHARGED	1.180 - 1.170
25% CHARGED	1.130 - 1.120
DISCHARGED	1.080 - 1.070

74579

NOTE: *It is the activity of the acid (hydrometer reading) which determines the activity of that cell.*

Storage

1. Remove battery and clean exterior.
2. Check fluid level and fill if low.
3. Cover terminals and bolts with light coat of grease.
4. Set battery on wood or in carton; store in cool, dry place.
5. Check every 20 days for fluid level and slow charge.

IMPORTANT: A discharged battery can be damaged by freezing.

Index

Charging Guide

12 Volt Battery Recommended Rate* and Time for Fully Discharged Condition

Twenty Hour Rating	5 Amperes	10 Amperes	20 Amperes	30 Amperes	40 Amperes	50 Amperes
50 Ampere-Hours or less	10 Hours	5 Hours	2-1/2 Hours	2 Hours		
Above 50 to 75 Ampere-Hours	15 Hours	7-1/2 Hours	3-1/2 Hours	2-1/2 Hours	2 Hours	1-1/2 Hours
Above 75 to 100 Ampere-Hours	20 Hours	10 Hours	5 Hours	3 Hours	2-1/2 Hours	2 Hours
Above 100 to 150 Ampere-Hours	30 Hours	15 Hours	7-1/2 Hours	5 Hours	3-1/2 Hours	3 Hours
Above 150 Ampere-Hours		20 Hours	10 Hours	6-1/2 Hours	5 Hours	4 Hours

* Initial rate for constant voltage taper rate charger

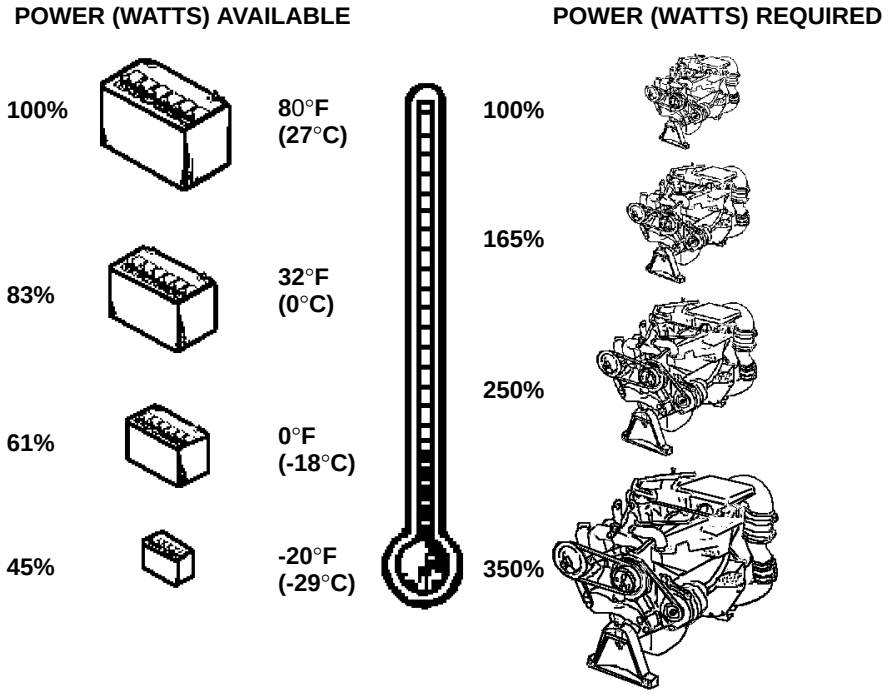
To avoid damage, charging rate must be reduced or temporarily halted, if:

1. Electrolyte temperature exceeds 125° F (52° C).
2. Violent gassing or spewing of electrolyte occurs.

Battery is fully charged when, over a two hour period at a low charging rate in amperes, all cells are gassing freely and no change in specific gravity occurs. For the most satisfactory charging, the lower charging rates in amperes are recommended.

Full charge specific gravity is 1.260-1.280, corrected for temperature with electrolyte level at split ring.

Battery Power as Affected by Temperature



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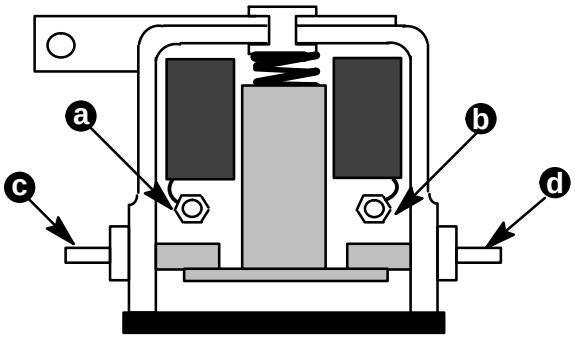
Index

Slave Solenoid Identification

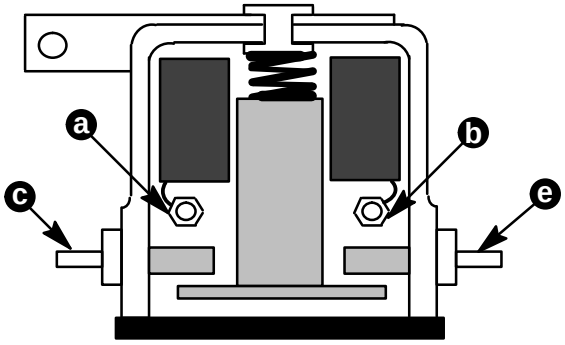
Types

There are two types of slave solenoids (“standard” or “switch”) used on MerCruiser engines. These engines use a standard type solenoid; **do not substitute a switch type solenoid.** The other engines use a slave solenoid to energize the starter motor solenoid. Some model engines use the small terminal on the “switch type” solenoid for ignition by-pass during the starting of the engine. Because of this, be sure to use correct type of slave solenoid for replacement.

Standard Type Slave Solenoid



OFF OR RUN POSITION

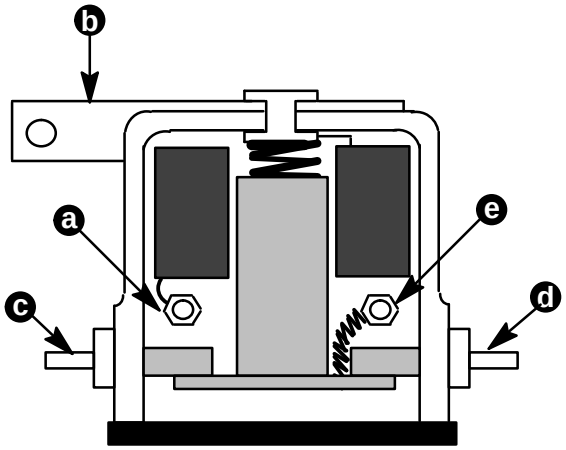


STARTING POSITION

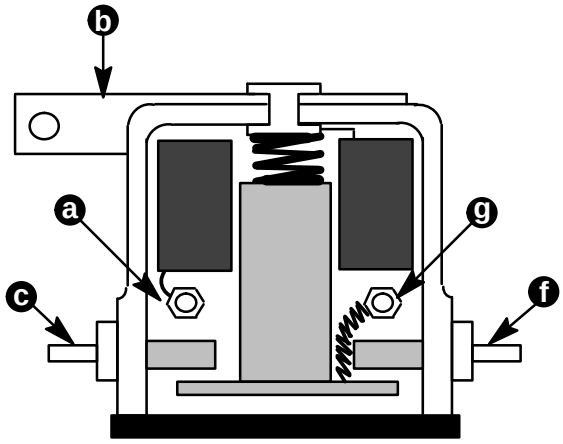
74581

a - From Key Switch (12 Volts In Start Position)
b - To Ground
c - 12 Volts From Battery
d - 0 Volts From Starter
e - 12 Volts To Starter

Switch Type Slave Solenoid



OFF OR RUN POSITION



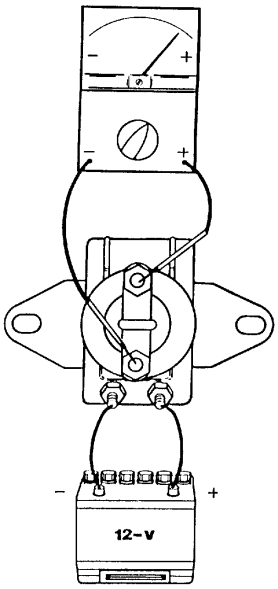
STARTING POSITION

74582

a - From Key Switch (12 Volts in Start Position)
b - Mounting Bracket and Ground
c - 12 Volts from Battery
d - 0 Volts To Starter
e - 0 Volts To Ignition Coil
f - 12 Volts To Starter
g - 12 Volts To Ignition Coil

Testing/Replacement

1. Using continuity meter, connect test leads as shown, and connect 12-volt battery with jumper leads as shown.



72630

2. If no meter movement is present, replace solenoid.

Index

Specifications

Part Number (Delco-Remy Number)	No Load Test					Brush Spring Tension Oz. (Grams)
	Volts	Min. Amps	Max. Amps	Min. RPM	Max. RPM	
50-812428A (9000762) 50-812604A (9000768)	10.6	60	90	3,000	3,300	83-104 oz. (2353-2948 g)
(1998317)	10.6	70	120	5400	10,800	56-105 (1588-2976)
Pinion Clearance				.010-.140 (0.25-3.5mm)		
Bearing Depth (Gear)				.011-.014 (0.28-0.38)		
Bearing Depth (Drive Housing)				.009-.017 (0.25-0.45)		
Commutator End Frame Gap				.025 MAX. (0.6mm MAX.)		

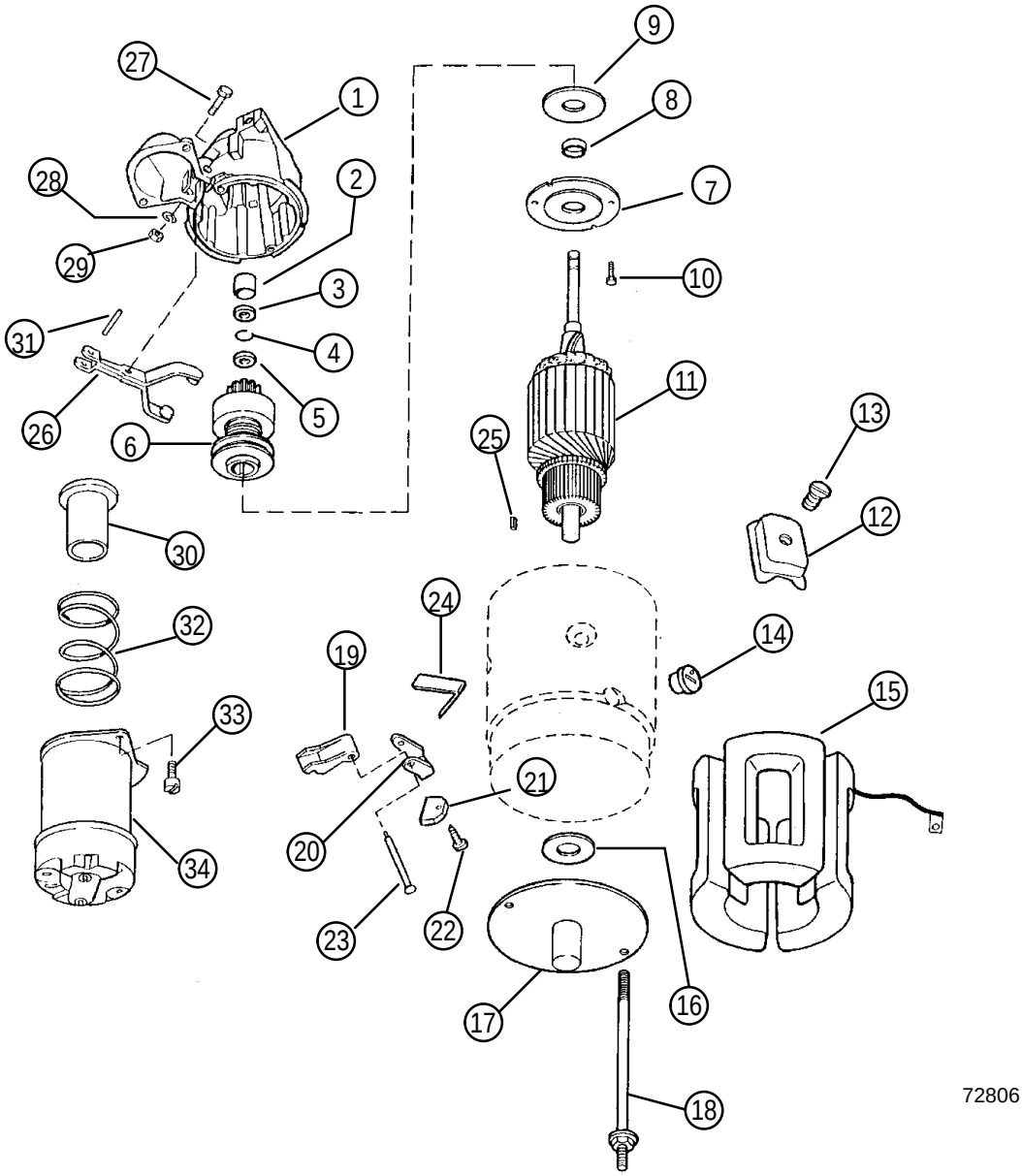
Torque Specifications

Fastener Location	Lb. Ft.	N·m
Starter Mounting Bolts	35	48
All Other Fasteners	Tighten Securely	

Lubricants/Sealants

Description	Part Number
Quicksilver Liquid Neoprene	92-25711--2
Quicksilver 2-4-C Marine Lubricant with Teflon	92-825407A3

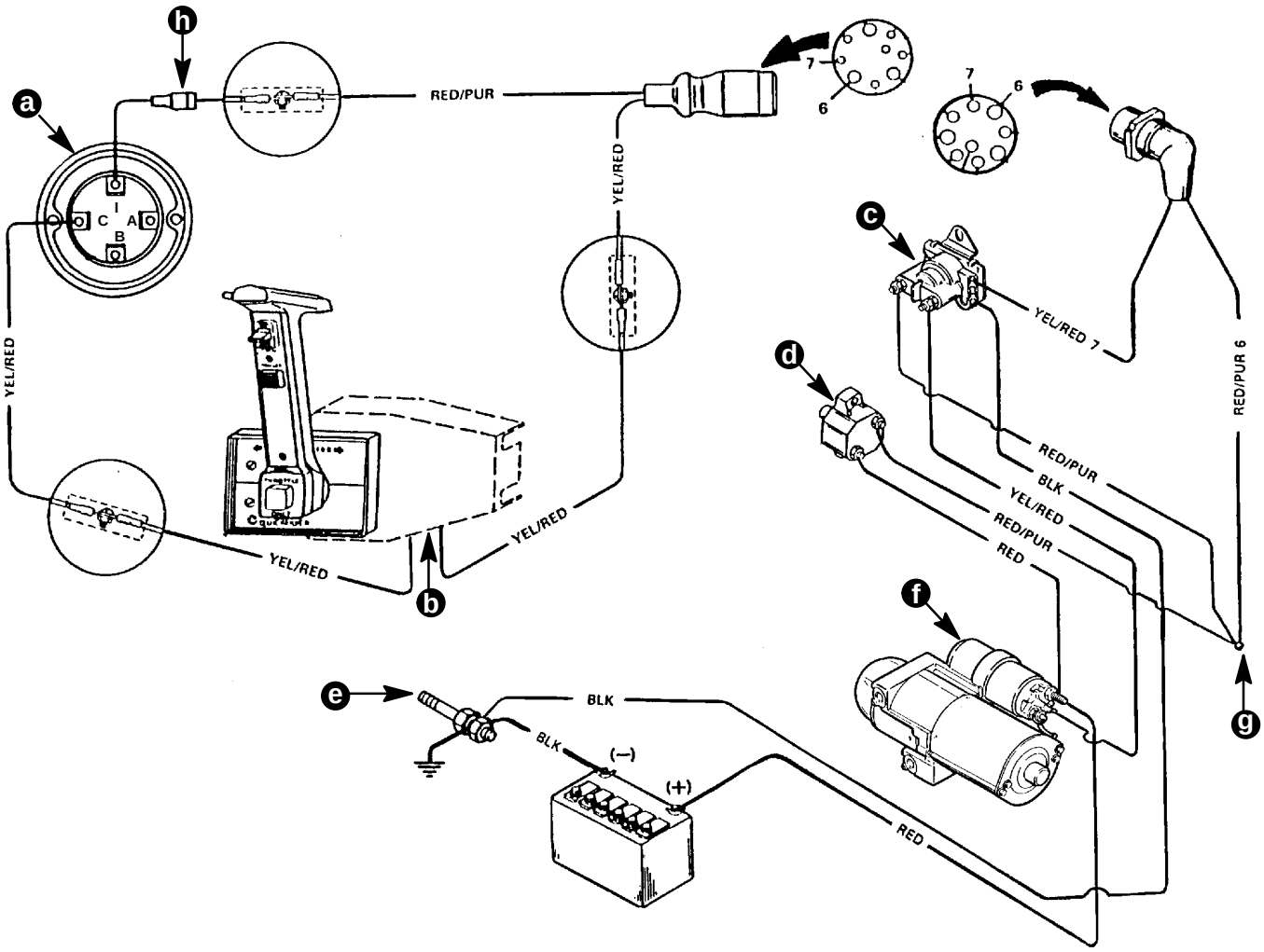
Starter Motor (Exploded View)



1 - Drive End Housing
2 - Drive End Housing Bushing
3 - Thrust Collar
4 - Retaining Ring - Pinion Stop Collar
5 - Pinion Stop Collar
6 - Clutch Drive Assembly
7 - Bearing Plate
8 - Bearing Plate Bushing
9 - Bearing Plate Washer
10 - Bearing Plate Screw
11 - Armature
12 - Pole Shoe - Field Coil
13 - Pole Shoe to Field Coil Screw
14 - Field Coil Grommet - Field Frame
15 - Field Coil Assembly
16 - Leather Washer - Commutator End Frame
17 - Lower Commutator End Frame
18 - Thru Bolt
19 - Insulated Holder - Field Frame Brush
20 - Field Frame Brush Ground Holder
21 - Field Frame Brush
22 - Brush Lead Screw
23 - Ground and Insulated Holders Support Package
24 - Field Frame Brush Spring
25 - Dowel Pin - Field Frame
26 - Shift Lever
27 - Shift Lever Stud
28 - Shift Lever Stud Washer
29 - Shift Lever Stud Nut
30 - Shift Lever Plunger
31 - Plunger to Shift Lever Pin
32 - Plunger Return Spring
33 - Solenoid Switch Screw
34 - Solenoid Switch Assembly

Index

Starting System Components



72929

a - Ignition Switch
b - Neutral Safety Switch
c - Starter Slave Solenoid
d - Circuit Breaker
e - Engine Ground Stud
f - Starter Solenoid
g - Wire Junction
h - 20 Amp Fuse

Index

Positive Current Flow

This is a general description of the positive current flow, from the battery and through the system until the starter motor cranks.

- Battery to the solenoid switch (on starter) (RED battery cable).
- Solenoid switch to circuit breaker (RED).
- Circuit breaker to wire junction (RED-PUR).
- Wire junction to wiring harness plug (RED-PUR) terminal 6.
- Wiring harness plug to 20 amp fuse (RED-PUR).
- 20 amp fuse to ignition switch terminal I (RED-PUR). At this point ignition switch is turned to START.
- Ignition switch terminal B to terminal S.
- Ignition switch terminal S to neutral start switch (YEL-RED). NEUTRAL START SWITCH MUST BE AT NEUTRAL POSITION.
- Neutral start switch to wiring harness plug terminal 7 (YEL-RED).
- Wiring harness plug to starter solenoid (small terminal) (YEL-RED). Also ensure that black (small terminal) wire is grounded.
- Starter solenoid is now “closed,” completing circuit between large terminal (RED-PUR) and other large terminal (YEL-RED), causing starter motor to crank.

⚠CAUTION

The starter motor is designed to operate under great overload and produce a high horsepower for its size. It can do this only for a short time, since considerable heat accumulates and can cause serious damage. For this reason, the cranking motor must never be used for more than 30 seconds at any one time. Cranking should not be repeated without a pause of at least 2 minutes to permit the heat to escape.

Periodic Inspection

Cranking motor and solenoid are completely enclosed in the drive housing to prevent entrance of moisture and dirt. However, periodic inspection is required as follows:

1. Inspect terminals for corrosion and loose connections.
2. Inspect wiring for frayed and worn insulation.
3. Check mounting bolts for tightness.

Starter Motor Repair

Removal

⚠WARNING

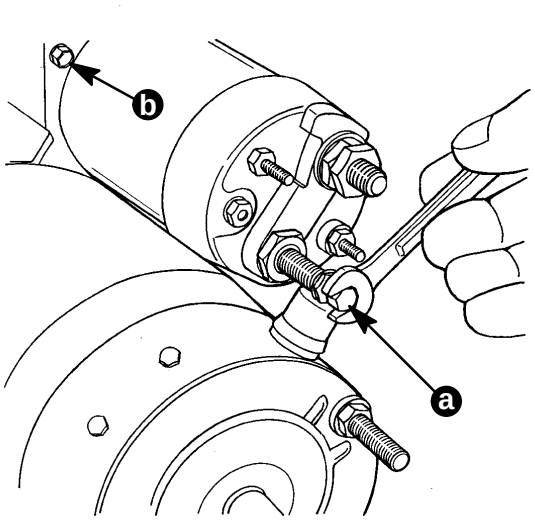
Disconnect battery cables at battery before removing starter.

1. Disconnect battery cables from battery.
2. Disconnect wires from solenoid terminals.
3. Remove starter mounting bolts.
4. Pull starter assembly away from flywheel and remove from engine.

Solenoid Switch

REMOVAL

1. Remove starter motor as outlined.
2. Remove screw from field coil connector and solenoid attaching screws.
3. Twist solenoid to disengage tab, and remove.



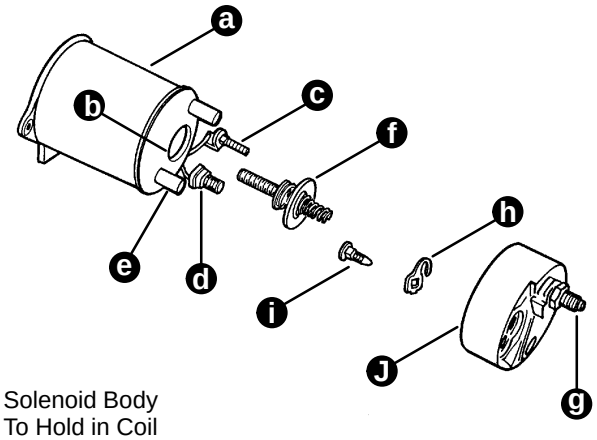
72631

a - Field Coil Screw
b - Attaching Screws

REPLACEMENT OF CONTACTS

1. With solenoid removed from motor, remove nuts and washers from switch terminal S and starter motor connector strap terminal.
2. Remove solenoid end cover retaining screws and washers and remove end cover from solenoid body.
3. Remove nut and washer from battery terminal on end cover and remove battery terminal.

IMPORTANT: DO NOT cut starter motor connector strap terminal wire (to remove terminal) or wire will be too short.



a - Solenoid Body
b - To Hold in Coil
c - Switch Terminal
d - Motor Connector Strap Terminal
e - To Pull in Coil
f - Contact Ring and Push Rod Assembly
g - Battery Terminal
h - Contact Finger
i - Screw
j - End Cover

72632

4. Remove motor connector strap terminal and solder new terminal in position.
5. Remove and install new battery terminal, washer and retaining nut to end cover.
6. Place new contact ring and push rod assembly in solenoid housing.
7. Position end cover over switch and motor terminals and install end cover retaining screws. Also install washers and nuts on solenoid switch and starting motor terminals.

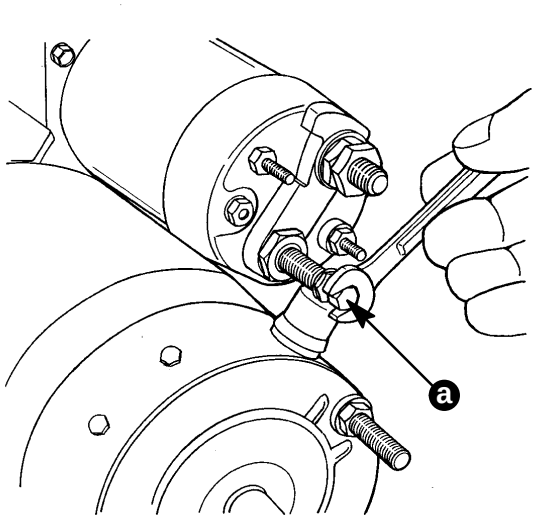
INSTALLATION

1. Install solenoid onto plunger.
2. Twist solenoid to engage tab.
3. Install screws and tighten securely.
4. Install field coil connector screw.

Index

Starter Motor Disassembly

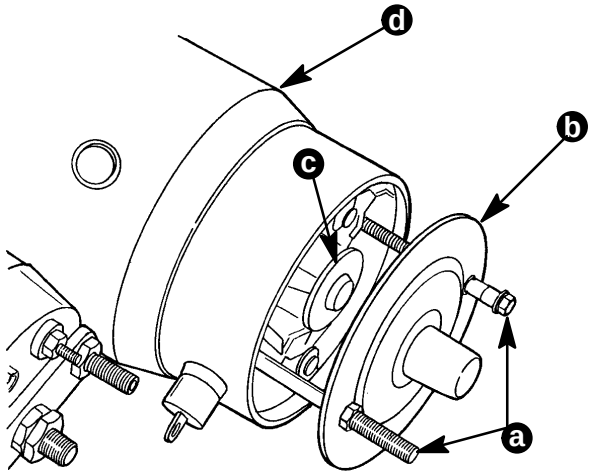
1. Remove screw from field coil connector.



72631

a - Connector Screw

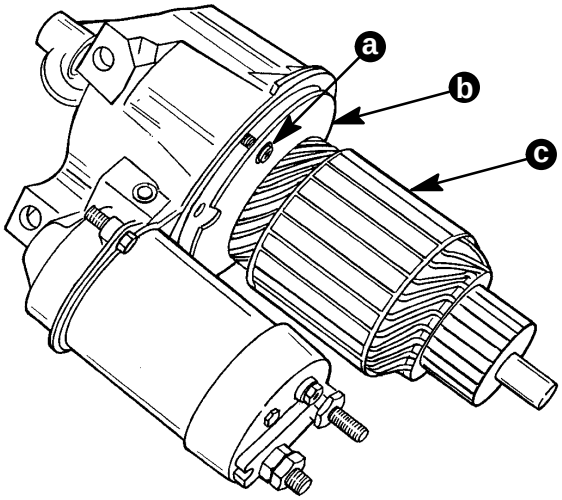
2. Remove end frame thru bolts, end frame, washer and field frame.



72633

a - Thru Bolts
b - End Frame
c - Washer
d - Field Frame

3. Remove screws, center bearing plate and armature.



72634

a - Screws
b - Bearing Plate
c - Armature

4. Slide thrust collar off armature shaft.
5. Drive retainer ring toward armature.
6. Remove snap ring, retainer and clutch assembly.

Cleaning and Inspection

With starting motor completely disassembled, except for removal of field coils, component parts should be cleaned and inspected. Field coils should be removed only where defects are indicated by tests. Defective parts should be replaced or repaired.

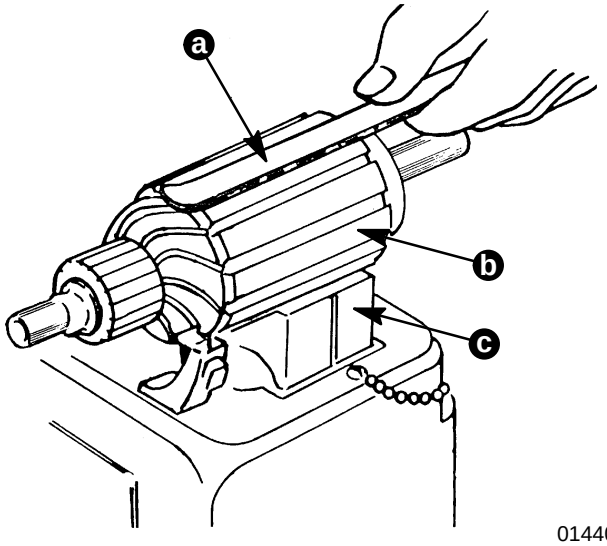
IMPORTANT: DO NOT use grease dissolving solvents for cleaning over-running clutch, armature and field coils. Such a solvent would dissolve grease packed in clutch mechanism and damage armature and field coil insulation.

1. Test over-running clutch action. Pinion should turn freely in over-running direction and must not slip in cranking direction. Check pinion teeth. Check spring for tension and drive collar for wear. Replace if necessary.
2. Check that brush holders are not damaged or bent and will hold brushes against commutator.
3. Check brushes. Replace if pitted or worn to one-half their original length [5/16 in. (8 mm) or less].
4. Check fit of armature shaft in bushing of drive housing. Shaft should fit snugly. Replace bushing, if worn. Apply SAE 20 oil to bushing before reassembly. Avoid excessive lubrication.
5. Check fit of bushing in commutator end frame. If bushing is damaged or worn excessively, replace end frame assembly. Apply SAE 20 oil to bushing before reassembly. Avoid excessive lubrication.
6. Inspect armature commutator. If rough or out-of-round, turn down and undercut. Inspect points (where armature conductors join commutator bars) for good, firm connection. Burned commutator bar usually is evidence of poor connection.

Armature Tests

TEST FOR SHORTS

Check armature for shorts by placing on growler and holding hack saw blade over armature core while rotating armature. If saw blade vibrates, armature is shorted. After cleaning between commutator bars, recheck. If saw blade still vibrates, replace armature.



01440

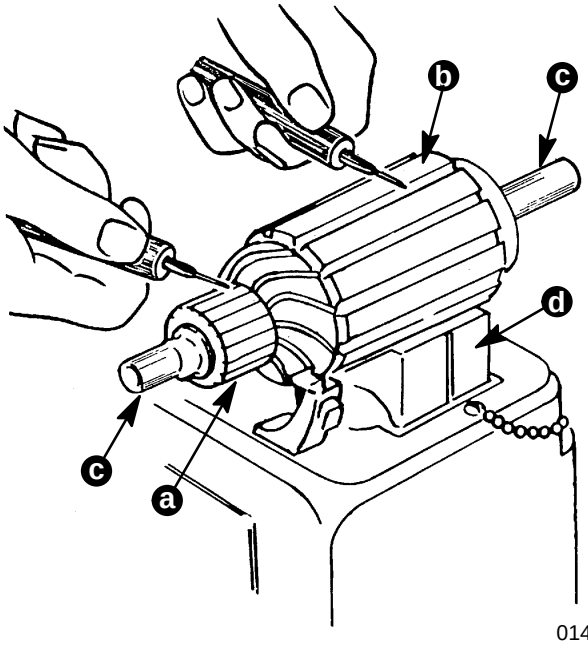
a - Hacksaw Blade
b - Armature Core
c - Growler

TEST FOR GROUND

1. With continuity meter, place one lead on armature core or shaft and other lead on commutator.

Index

2. If meter hand moves, armature is grounded and must be replaced.



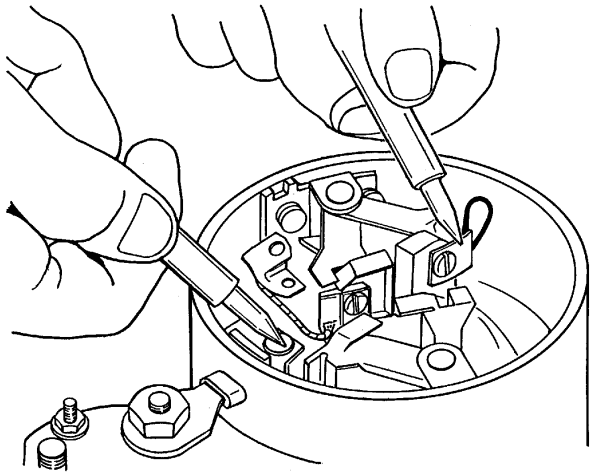
01441

a - Commutator
b - Armature Core
c - Shaft
d - Growler

Field Coil Tests

TEST FOR OPEN CIRCUIT

1. With continuity meter, place one lead on each end of field coils (insulated brush and field connector bar).



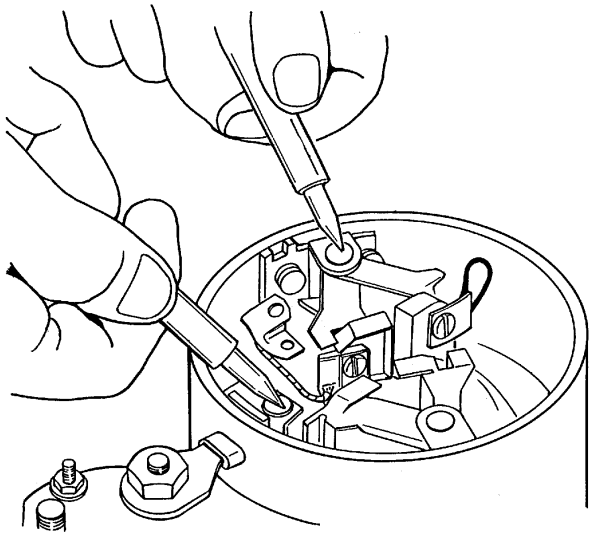
72635

2. If meter does not move, field coils are open and must be replaced.

TEST FOR GROUND

IMPORTANT: Be sure that positive brushes and leads do not contact field frame assembly during test, or false reading will result.

1. With continuity meter, place one lead on field connector bar and other lead on grounded brush.



72636

2. If meter hand moves, field coils are grounded and must be replaced.

Loose Electrical Connections

If open soldered connection of armature to commutator leads is found during inspection, resolder with resin flux.

IMPORTANT: Never use acid flux on electrical connections.

Turning the Commutator

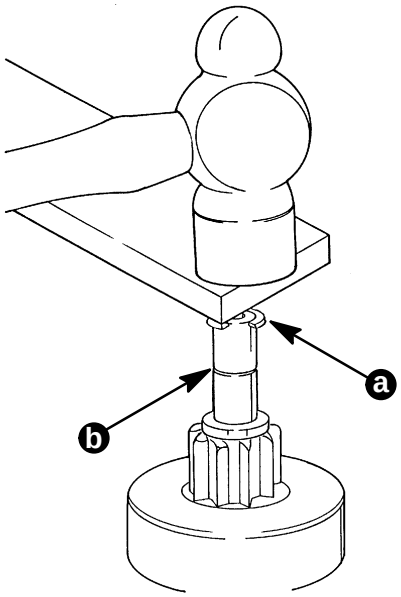
When inspection shows commutator roughness, clean as follows:

1. Turn down commutator in a lathe until thoroughly cleaned.
2. Recheck armature for shorts as outlined.

Reassembly

After all parts are thoroughly tested and inspected and worn or damaged parts replaced, reassemble starter as follows:

1. Assemble brushes and related parts to field frame as follows:
   a. Assemble brushes to brush holders. Attach ground wire to grounded brush and field lead wire to insulated brush.
   b. Assemble insulated and grounded brush holders together with V-spring. Position as a unit and install support pin. Push holders and spring to bottom of support and rotate spring to engage center of V-spring in slot in support.
2. Assemble over-running clutch assembly to armature shaft as follows:
   a. Lubricate drive end of armature shaft with SAE 10 oil.
   b. Slide assist spring and clutch assembly onto armature shaft with pinion outward.
   c. Slide retainer onto shaft with cupped surface facing end of shaft (away from pinion).
   d. Drive snap ring onto shaft and slide down into groove.



72073

a - Snap Ring
b - Groove

   e. Assemble thrust collar on shaft with shoulder next to snap ring.
   f. Place thrust collar and retainer next to snap ring and using two pliers squeeze both until snap ring is forced into retainer.
3. Place 4 or 5 drops of light engine oil in drive housing bushing. Slide armature and clutch assembly into place while engaging shift lever with clutch.
4. Position field frame over armature and apply Quicksilver Liquid Neoprene between frame against drive housing, observing caution to prevent damage to brushes.
5. Place 4 to 5 drops of light engine oil in bushing in commutator end frame. Place brake washer and commutator end frame onto shaft.
6. Install solenoid return spring on plunger.
7. Position solenoid assembly to starter motor end frame and turn solenoid to engage flange in slot.
8. Install (and tighten securely) screws which hold solenoid assembly to end frame.
9. Secure starter motor connector strap terminal with screw and washer.

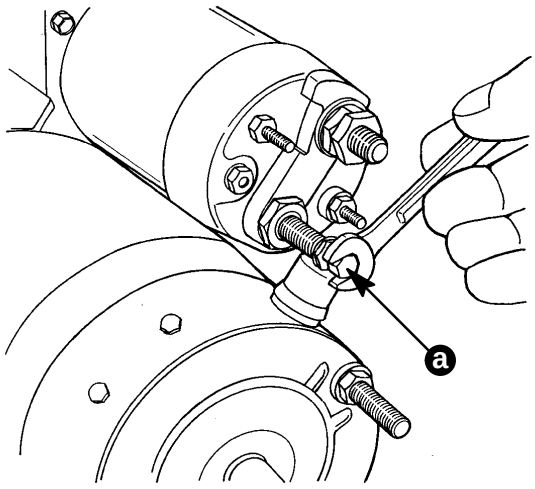
Index

Clearances

PINION CLEARANCE

Pinion clearance must be checked as follows after reassembly of motor to insure proper adjustment.

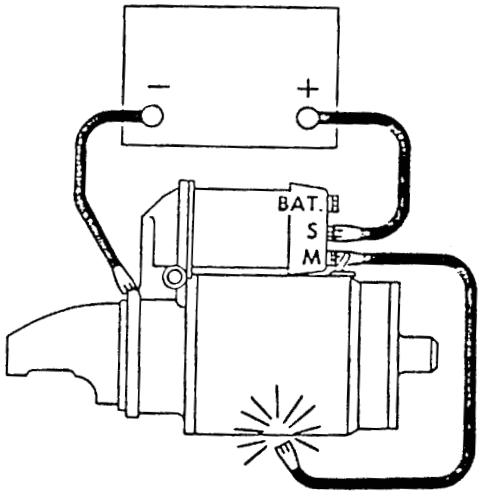
1. Disconnect motor field coil connector from solenoid motor terminal and insulate it carefully.



72631

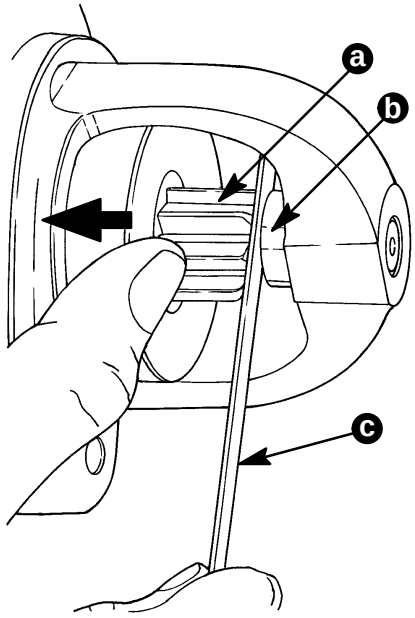
a - Motor Field Coil Connector

2. Connect 12 volt battery positive (+) lead to solenoid switch and negative (–) lead to solenoid frame.
3. Momentarily touch a jumper lead from solenoid motor terminal M to starter motor frame. This shifts pinion into cranking position where it will remain until battery is disconnected.



01447

4. Push pinion back toward commutator end to eliminate slack.
5. Measure distance between pinion and pinion retainer.
6. If clearance is not within limits of .010-.140 in. (0.25-3.5 mm), it may indicate excessive wear of solenoid linkage shift lever yoke buttons or improper assembly of shift lever mechanism. Check for proper assembly, and recheck gap. If still excessive, replace worn or defective parts, since no provision is made for adjusting pinion clearance.



72077

a - Pinion
b - Retainer
c - Feeler Gauge

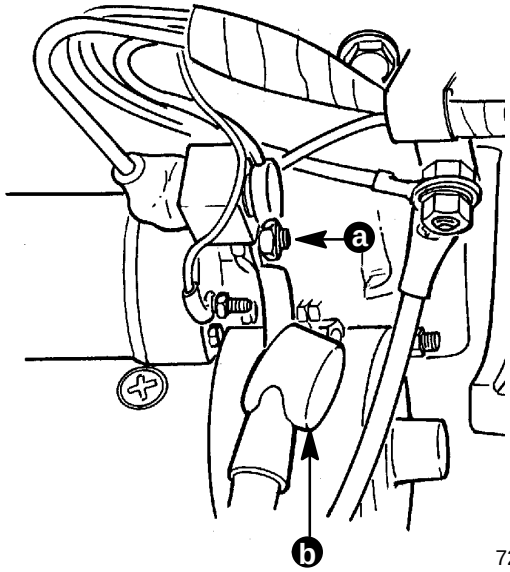
COMMUTATOR END FRAME GAP

To keep the ignition-proof and safety requirement, the gap between the commutator end frame and field coil housing must be checked. See specifications. If the gap exceeds measurement when checked with a feeler gauge, the end frame should be checked for proper seating on the field coil housing. If properly seated and still found to have excessive gap, the end frame must be replaced.

Index

Installation

1. Place starter motor and solenoid assembly in position and install mounting bolts. Torque bolts to 50 lb. ft. (68 N·m).
2. Fasten wires as outlined in wiring diagram.
3. Coat solenoid terminal connections with Quicksilver Liquid Neoprene.
4. Place rubber boot over positive battery cable connection.



72637

a - Positive Battery Cable
b - Rubber Boot

Delco PG200 and PG260 Starters

Description

The Delco PG 200 and PG260 starter motor features small permanent magnets mounted inside the field frame. These magnets take the place of current-carrying field coils mounted on iron pole pieces. Internal gear reduction, approximately 4 to 1, through planetary gears results in armature speeds in the 7000 RPM range. The armature and drive shaft are mounted on roller or ball bearings in place of bushings. The solenoid switch, plunger, return spring, and shift lever are permanently mounted in the drive housing.

Index

PG200 Specifications

Delco I.D. Number	Engine Rotation	No Load Test					Brush Spring Tension Oz. (Grams)
		Volts	Min. Amps	Max. Amp	Min. RPM	Max. RPM	
9000763 9000768	LH	10.6	60	90	3000	3300	83-104 oz. (2352-2948)
Pinion Clearance				.101-.160 (.025-4.06mm)			
Bearing Depth (Gear)				.011-.014 (0.28-.038mm) Maximum			
Bearing Depth (Housing)				.009-.017 (0.4mm) Maximum			

PG260 Specifications

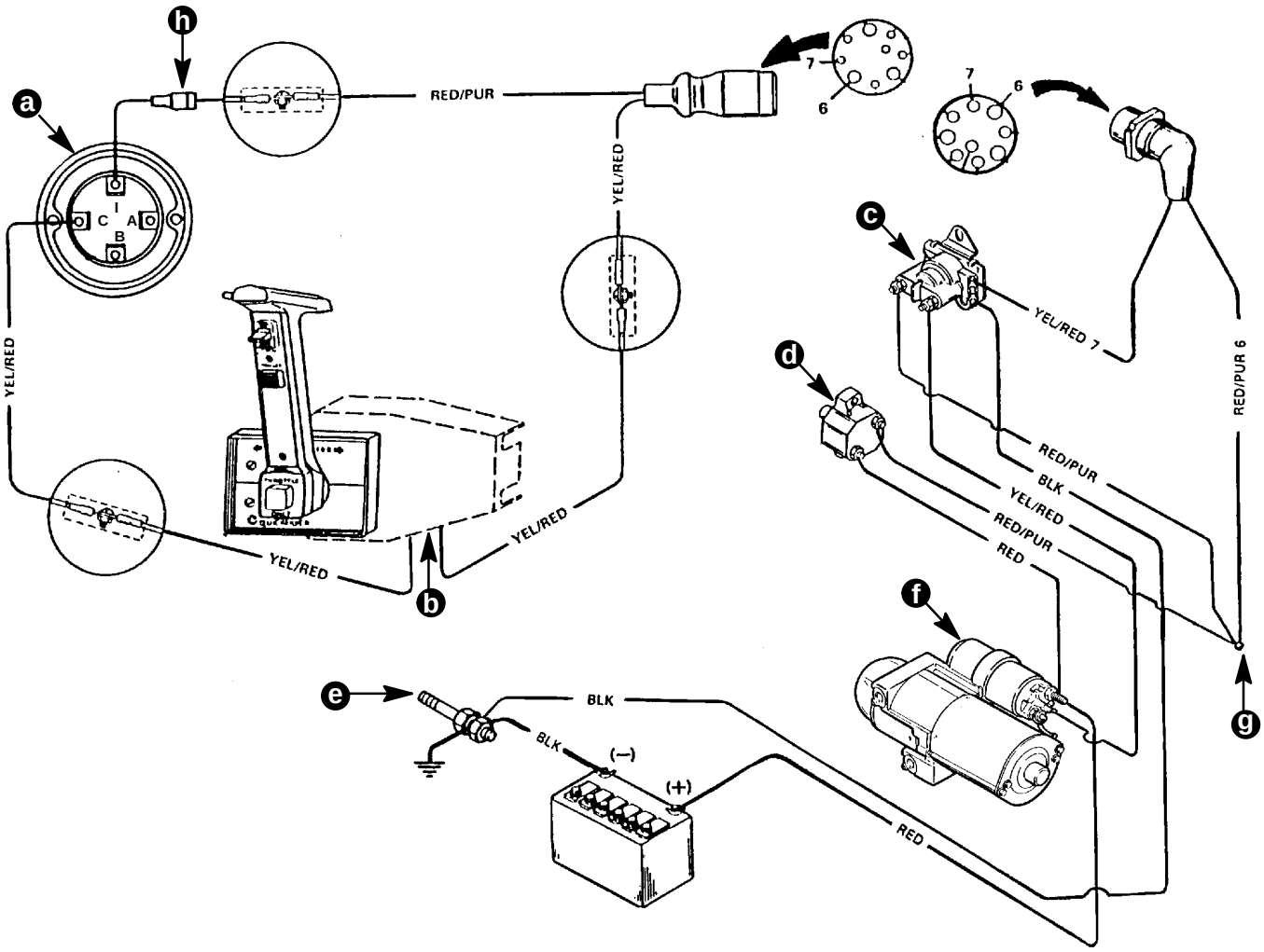
Delco I.D. Number	Engine Rotation	No Load Test					Brush Spring Tension Oz. (Grams)
		Volts	Min. Amps	Max. Amp	Min. RPM	Max. RPM	
9000820	LH	10.6	60	95	2750	3250	83-104 oz. (2352-2948)
Pinion Clearance				.101-.160 (.025-4.06mm)			
Bearing Depth (Gear)				.011-.014 (0.28-.038mm) Maximum			
Bearing Depth (Housing)				.009-.017 (0.4mm) Maximum			

Torque Specification

Fastener Location	Lb. Ft	N·m
Starter Mounting Bolts	30	41
Fastener Not Listed	Tighten Securely	

NOTE: *The PG260 starter cannot be rebuilt. The only replacement components available are the solenoid and drive housing.*

Starting System Components

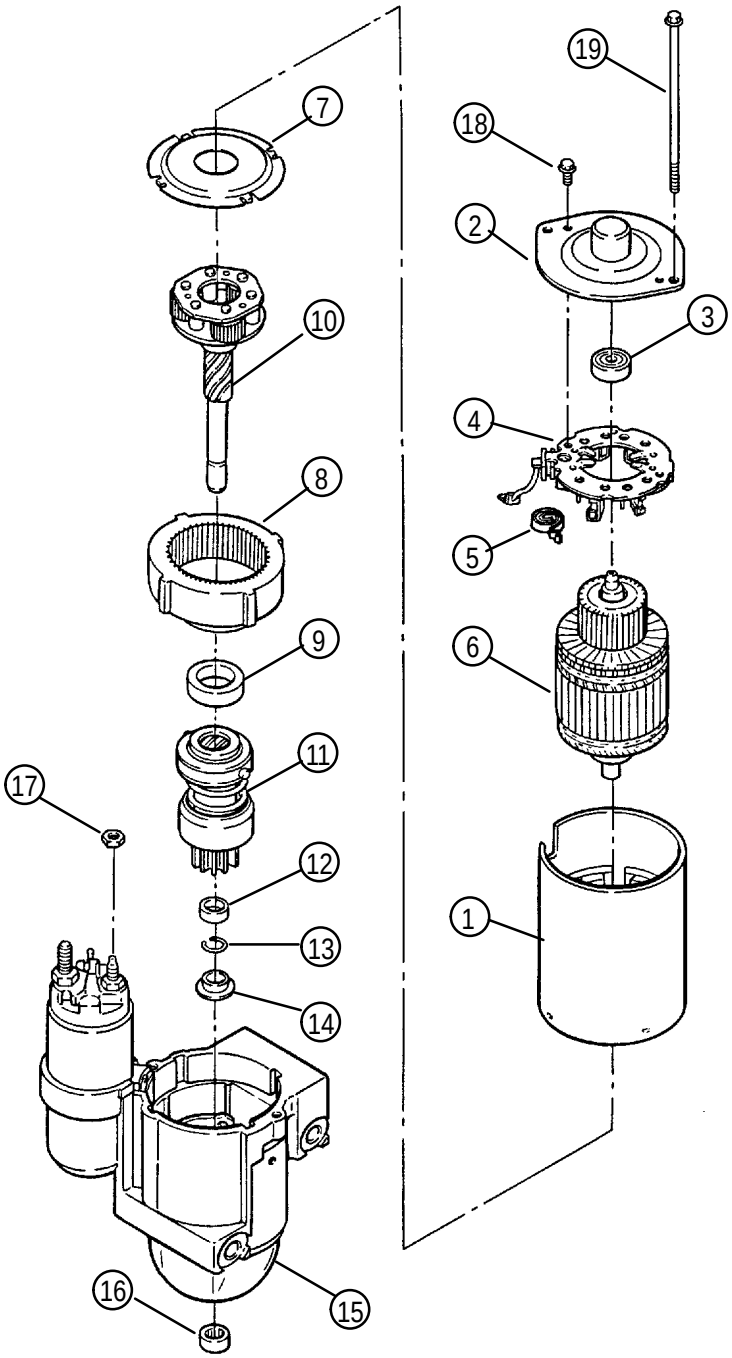


72929

a - Ignition Switch
b - Neutral Safety Switch
c - Starter Slave Solenoid
d - Circuit Breaker
e - Engine Ground Stud
f - Starter Solenoid
g - Wire Junction
h - 20 Amp Fuse

Index

PG200 Exploded View



72079

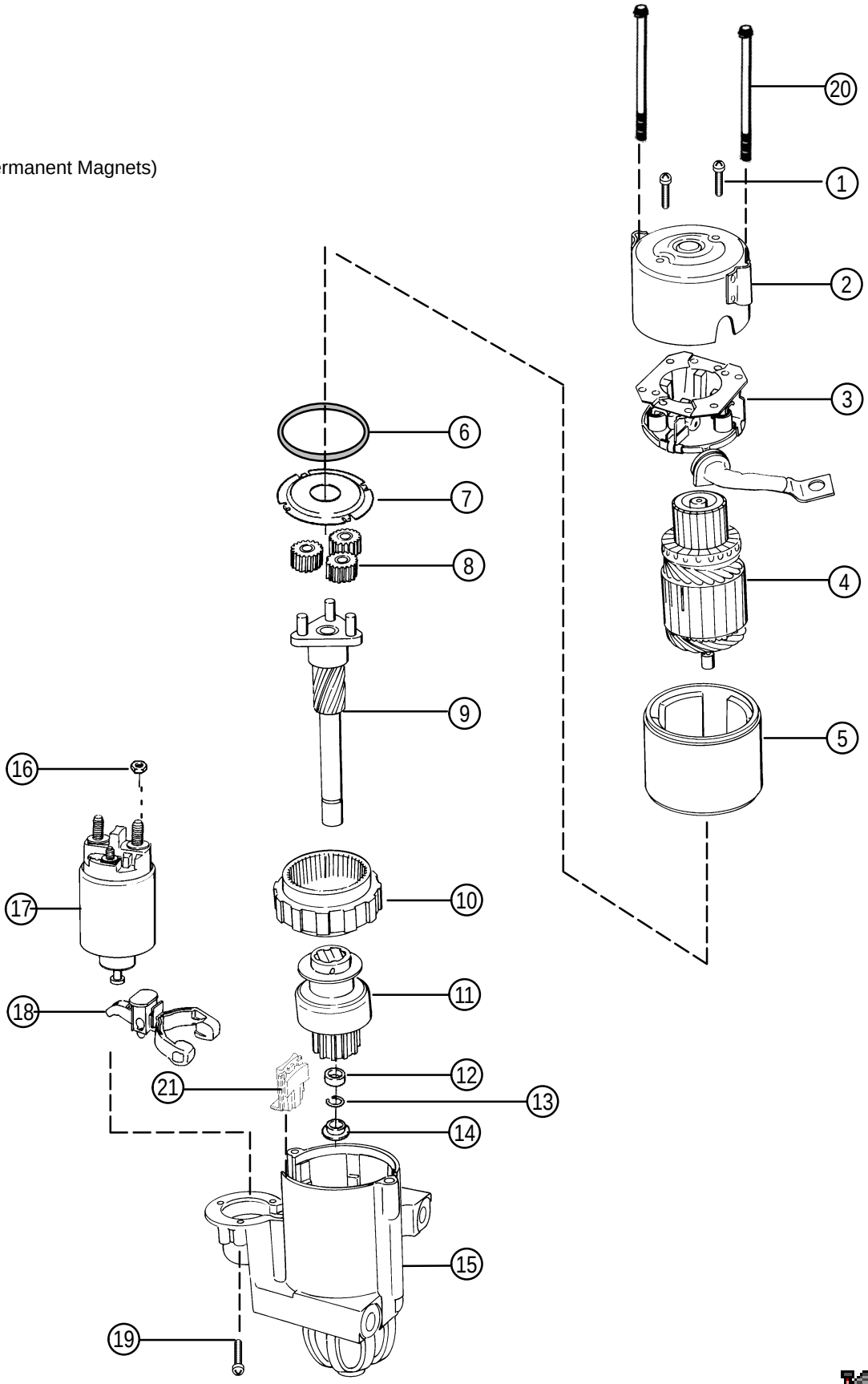
1 - Field Frame (with Permanent Magnets)
2 - End Frame
3 - Ball Bearing
4 - Brushes with Holder
5 - Brush Spring
6 - Armature
7 - Shield
8 - Gear
9 - Roller Bearing
10 - Planetary Gear and Shaft Assembly
11- Drive
12 - Collar
13 - Retaining Ring
14 - Thrust Collar
15 - Drive Housing*
16 - Roller Bearing
17 - Nut
18 - Screw
19 - Thru Bolt

* Contains: Starter Solenoid, Plunger, Return Spring and Shift Lever

Index

PG260 Exploded View

1 - Screw (2)
2 - End Cap
3 - Brushes with Holder
4 - Armature
5 - Field Frame (with Permanent Magnets)
6 - Washer
7 - Shield
8 - Planetary Gears
9 - Shaft
10 - Gear
11- Drive
12 - Collar
13 - Retaining Ring
14 - Thrust Collar
15 - Drive Housing
16 - Nut
17 - Solenoid
18 - Solenoid Drive Arm
19 - Screw (3)
20 - Thru Bolt (2)
21 - Rubber Grommet



Index

⚠CAUTION

The starter motor is designed to operate under great overload and produce a high horsepower for its size. It can do this only for a short time, since considerable heat accumulates and can cause serious damage. For this reason, the cranking motor must never be used for more than 30 seconds at any one time. Cranking should not be repeated without a pause of at least 2 minutes to permit the heat to escape.

Solenoid Switch

The solenoid switch, along with plunger, return spring, and shift lever, are completely sealed and permanently mount-ed in the drive housing. If solenoid is defective, entire drive housing must be replaced.

Periodic Inspection

Cranking motor and solenoid are completely enclosed in the drive housing to prevent entrance of moisture and dirt. However, periodic inspection is required as follows:

1. Inspect terminals for corrosion and loose connections.
2. Inspect wiring for frayed and worn insulation.
3. Check starter mounting bolts for tightness.

Starter Motor Repair

Removal

⚠WARNING

Disconnect battery cables at battery before removing starter.

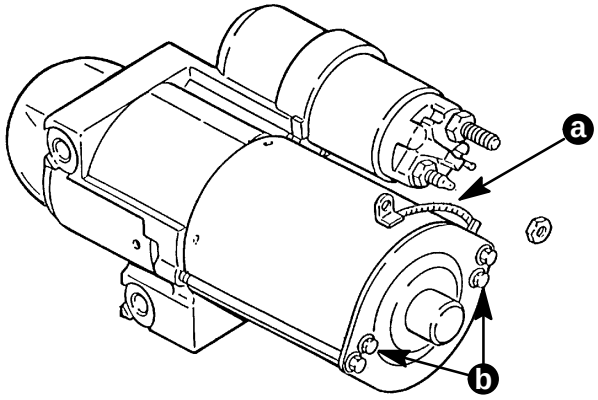
1. Disconnect battery cables from battery.
2. Disconnect wires from solenoid terminals.

IMPORTANT: Some starter motors may use a special mounting shim for gaining flywheel clearance. Do not lose this shim; it will be needed when remounting starter on engine block.

3. Remove starter mounting bolts.
4. Pull starter assembly away from flywheel and remove from engine.

PG200 Disassembly

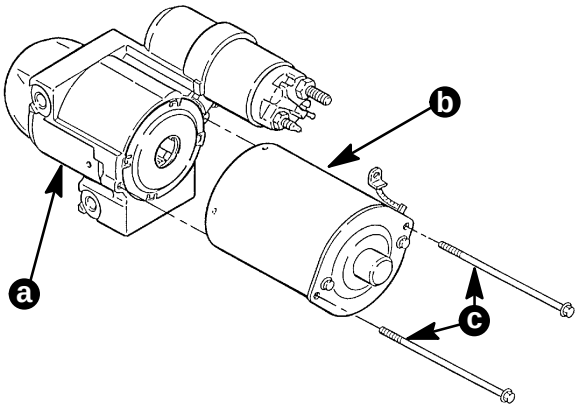
1. Remove brush lead from solenoid and screws from end frame.



72060

a - Brush Lead
b - Screws

2. Remove thru bolts and separate field frame with armature from drive housing.

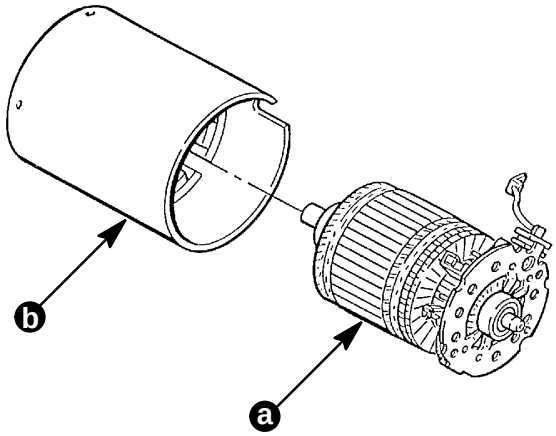


72061

a - Field Frame/Armature
b - Drive Housing
c - Thru Bolts

3. Pull armature out of field frame.

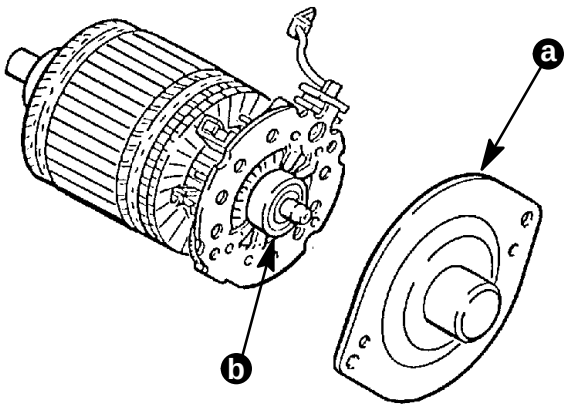
NOTE: *Permanent magnets inside field frame will be holding armature in place.*



72062

a - Armature
b - Field Frame

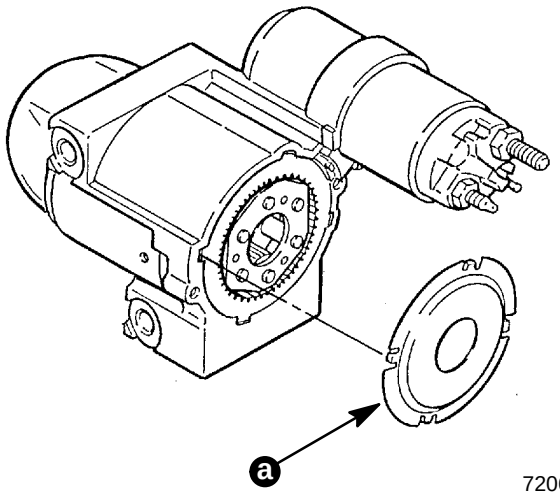
4. Pull end frame off bearing.



72063

a - End Frame
b - Bearing

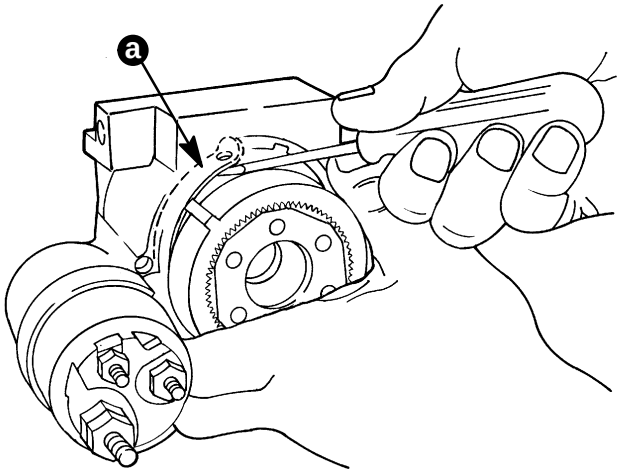
5. Remove shield.



72065

a - Shield

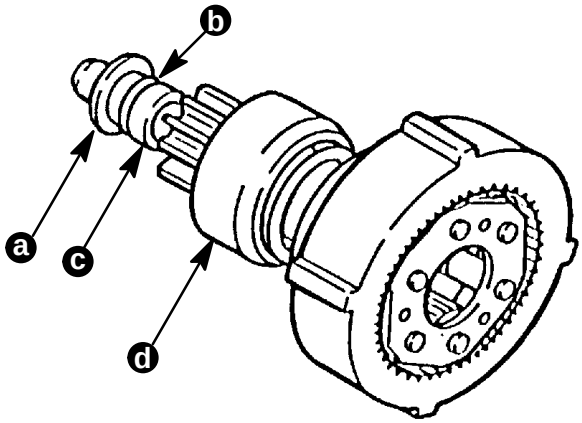
6. Use a screwdriver, as shown, to disengage shift lever from drive.



72064

a - Shift Lever

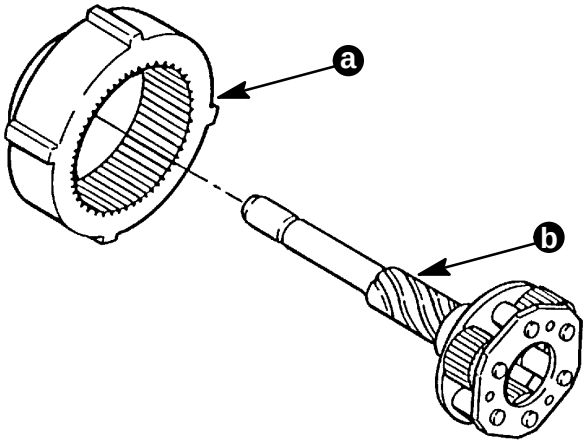
7. Remove thrust collar, retaining ring and collar. Remove drive.



72067

a - Thrust Collar
b - Retaining Ring
c - Collar
d - Drive

8. Remove gear from shaft assembly.



72066

a - Gear
b - Shaft Assembly

Cleaning and Inspection

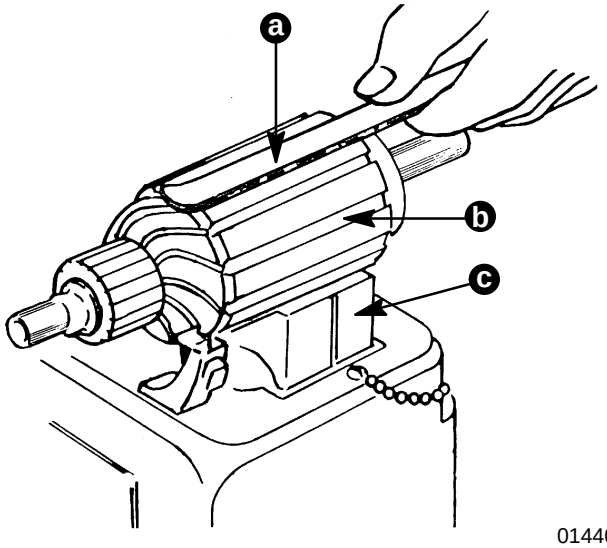
IMPORTANT: Do not use grease dissolving solvents to clean electrical components, planetary gears, or drive. Solvent will damage insulation and wash the lubricant out of the drive and gears. Use clean rags and compressed air to clean components.

1. Test over-running clutch action of drive. Pinion should turn freely in over-running direction and must not slip in cranking direction. Check pinion teeth. Check spring for tension and drive collar for wear. Replace if necessary.
2. Check that brush holders are not damaged or bent and hold brushes against commutator. Check brushes for wear; refer to “Brushes and Brush Holder.”
3. Inspect armature commutator. If badly grooved or out-of-round, turn down and undercut commutator.
4. Inspect all roller bearing surfaces for wear. Check that bearings roll freely. If any roughness is felt, replace bearings.
5. Inspect planetary gear assembly. Gears must mesh easily and roll freely with no binding.

Armature Tests

TEST FOR SHORTS

Check armature for shorts by placing on growler and holding hack saw blade over armature core while rotating armature. If saw blade vibrates, armature is shorted. After cleaning between commutator bars, recheck. If saw blade still vibrates, replace armature.



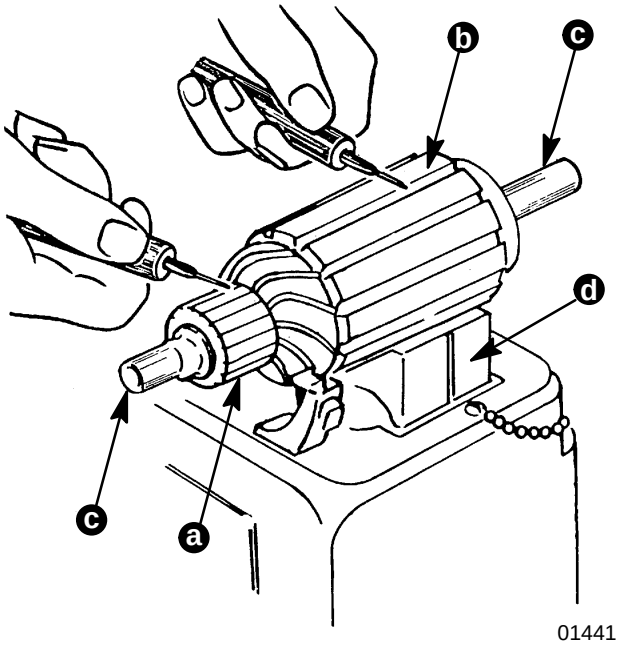
01440

a - Hacksaw Blade
b - Armature Core
c - Growler

TEST FOR GROUND

1. With continuity meter, place one lead on armature core or shaft and other lead on commutator.

2. If meter hand moves, armature is grounded and must be replaced.



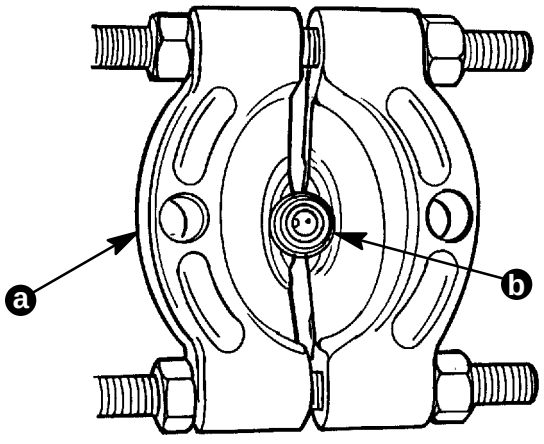
01441

a - Commutator
b - Armature Core
c - Shaft
d - Growler

Armature Bearing (Commutator End)

REMOVAL

Use a universal puller plate, as shown, to remove bearing.



72068

a - Universal Puller Plate
b - Bearing

INSTALLATION

IMPORTANT: Brush holder must be installed on armature before installing armature bearing.

Using the correct size driver, press on inner bearing race until it contacts shoulder of armature shaft.

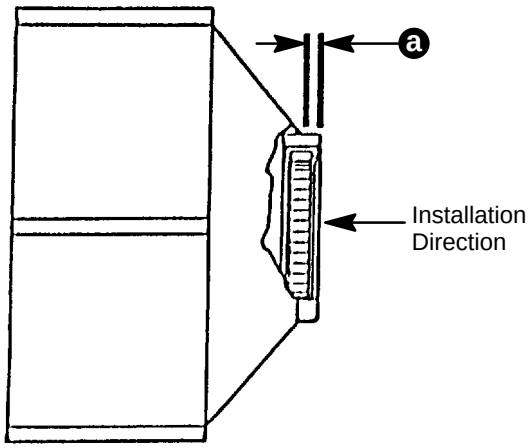
Gear Bearing

REMOVAL

Using the correct size driver, press bearing out of gear.

INSTALLATION

1. Using the correct size driver, press bearing into gear, from direction shown, to depth specified.



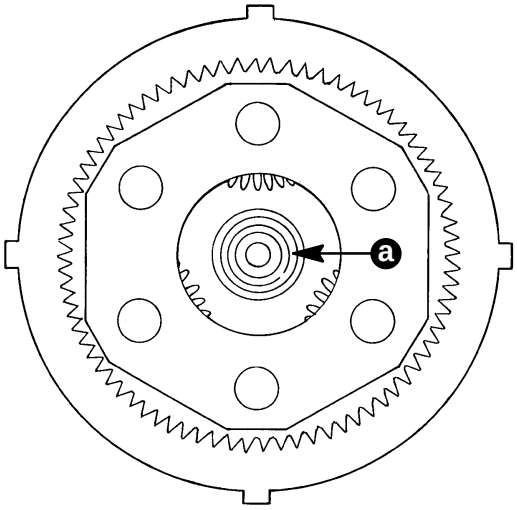
72625

a - Depth - .011-.014 in. (0.28-0.38 mm)

2. Lubricate bearing and gear teeth with a small amount of Quicksilver 2-4-C Marine Lubricant with Teflon.

Shaft Assembly Bearing

IMPORTANT: Roller bearing is not replaceable. If bearing is defective, replace entire shaft assembly. Apply Quicksilver 2-4-C Marine Lubricant with Teflon to bearing before starter reassembly.



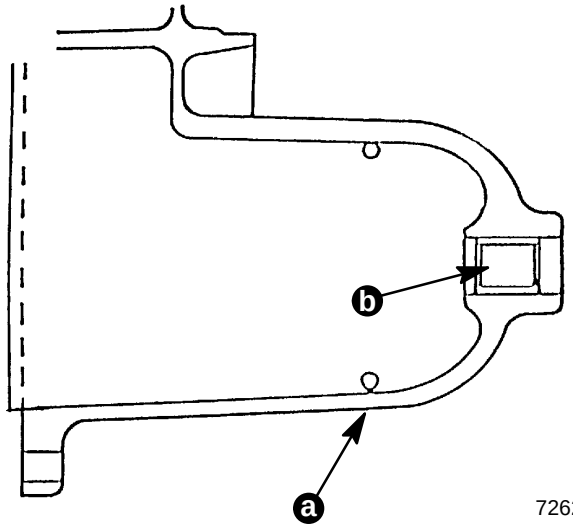
72070

a - Roller Bearing

Drive End Housing Bearing

REMOVAL

Using the correct size driver, press bearing out of housing.

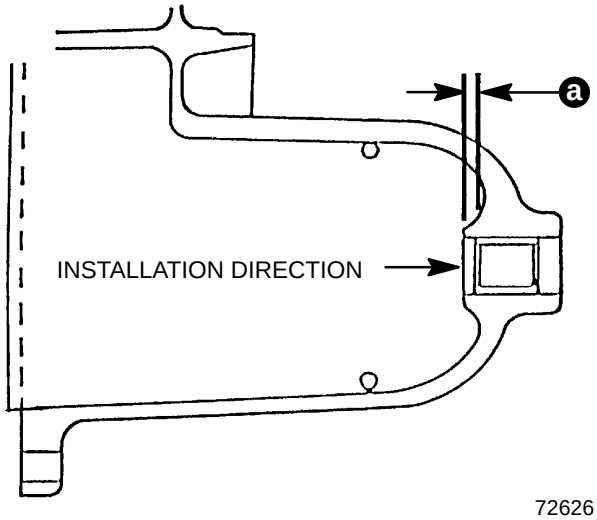


72626

a - Drive End Housing
b - Bearing

INSTALLATION

1. Using the correct size driver, press bearing into housing, from direction shown, to depth specified.



72626

a - Depth - .009-.017 in. (0.25-0.45 mm)

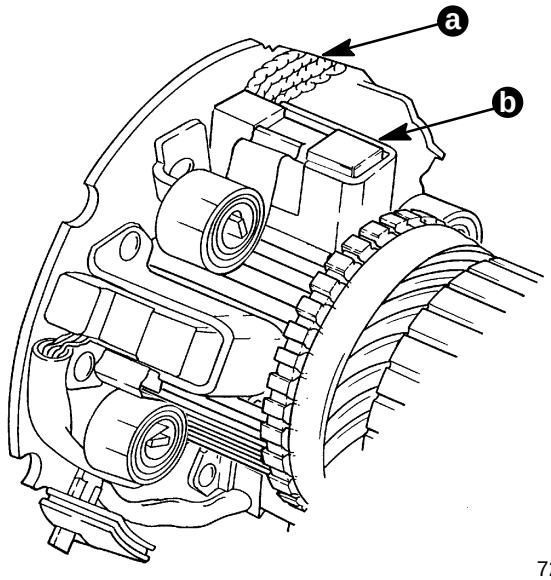
2. Lubricate bearing with a small amount of Quicksilver 2-4-C Marine Lubricant with Teflon.

Brushes and Brush Holder

INSPECTION

Replace brushes and holder when brush leads are touching guide.

Make sure brushes move freely in guides.



72069

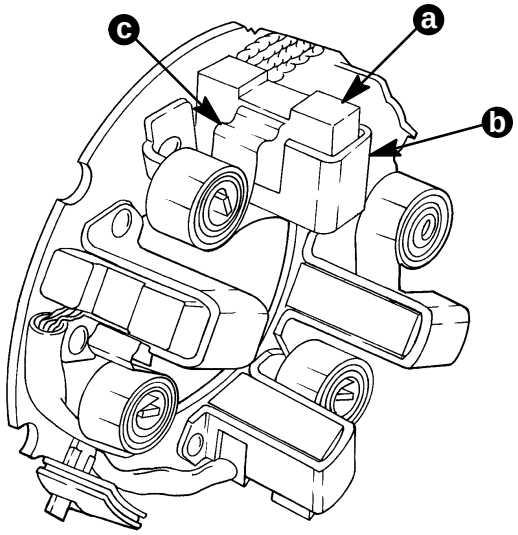
a - Brush Leads
b - Guide

REMOVAL

1. Remove armature bearing as previously described.
2. Remove brush holder.

INSTALLATION

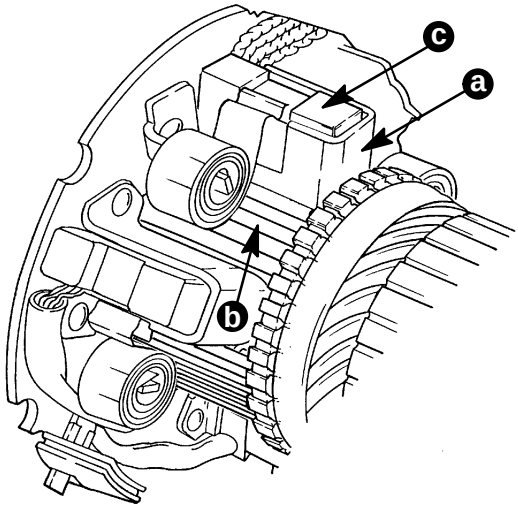
1. Push each brush up into its guide to allow spring to hold it in place, as shown.



72072

a - Brush
b - Guide
c - Brush Spring

2. Place brush holder on armature and push brushes down against commutator, as shown.



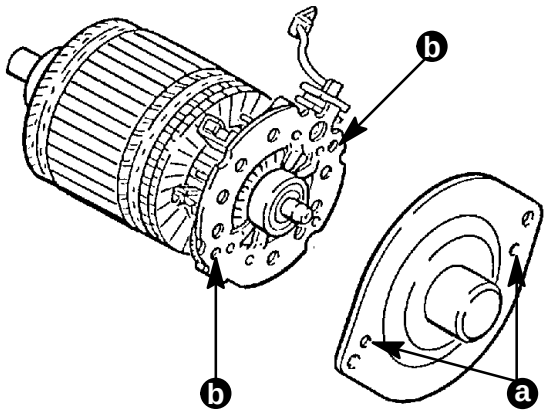
72069

a - Brush Holder
b - Commutator
c - Brush

3. Install armature bearing as previously described.

PG200 Reassembly

1. Install end frame on brush holder. Align holes of end frame with holes of brush holder. Tighten screws securely.

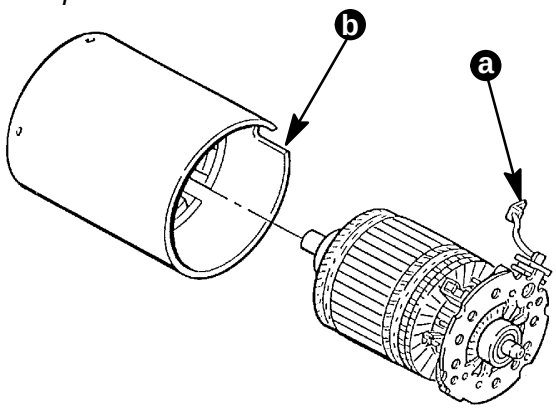


72063

a - Holes of End Frame
b - Holes of Brush Holder

2. Insert armature into field frame. Align brush holder lead with notch in field frame.

NOTE: *Permanent magnets in field frame will pull armature in place.*

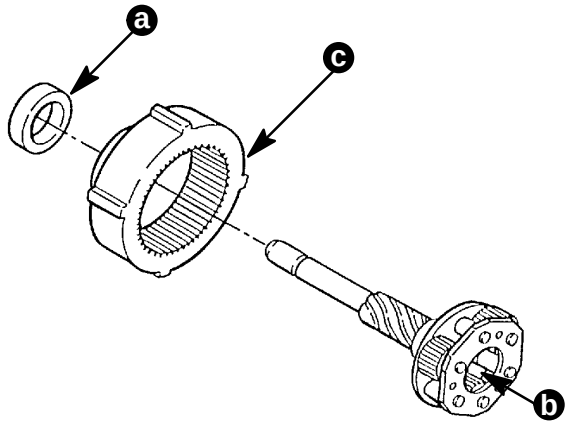


72062

a - Brush Holder Lead
b - Notch

Index

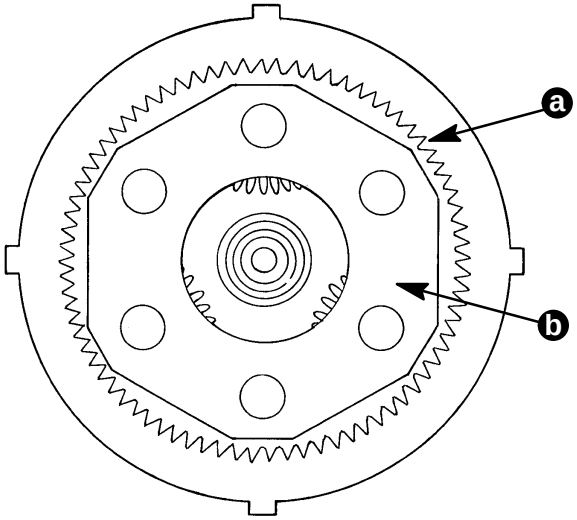
3. Coat roller bearings and gear with a small amount of Quicksilver 2-4-C Marine Lubricant with Teflon.



72627

a - Roller Bearing
b - Roller Bearing
c - Gear

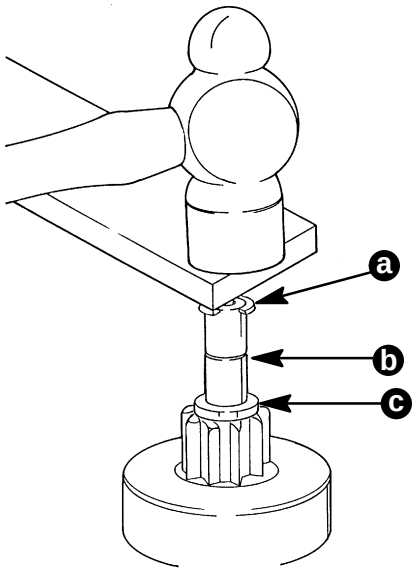
4. Assemble gear and shaft together, as shown.



72070

a - Gear Assembly
b - Shaft Assembly

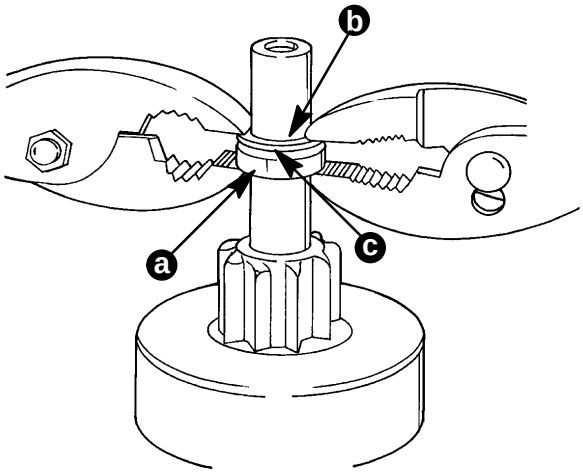
5. Assemble drive on shaft assembly as follows:
   a. Lubricate drive end of shaft assembly with SAE 10W oil.
   b. Slide drive assembly onto shaft with pinion outward.
   c. Slide retainer onto shaft with cupped surface facing end of shaft (away from pinion).
   d. Position snap ring on upper end of shaft and hold in place with block of wood. Strike wood block with hammer, thus forcing snap ring over end of shaft. Slide snap ring down into groove.



72073

a - Snap Ring
b - Groove
c - Retainer

   e. Assemble thrust collar on shaft with shoulder next to snap ring.
   f. Position retainer and thrust collar next to snap ring. Then, using two pliers, grip retainer and thrust collar and squeeze until snap ring is forced into retainer.

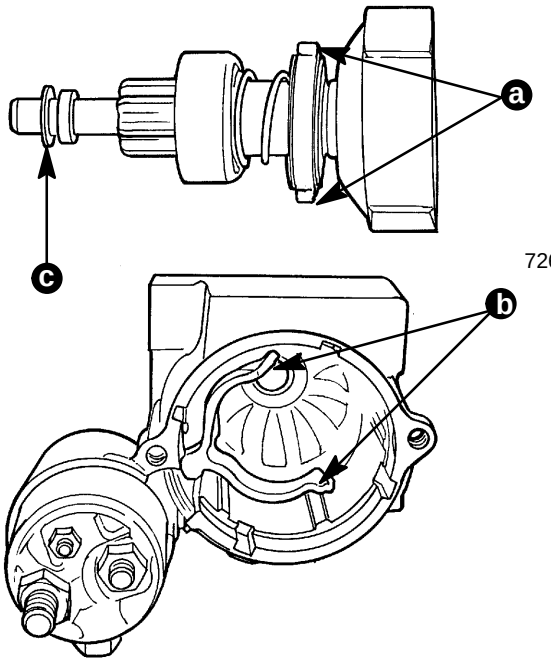


72074

a - Retainer
b - Thrust Collar
c - Snap Ring

6. Apply a thin coating of Quicksilver 2-4-C Marine Lubricantwith Teflon to roller bearing in drive housing.

7. Insert shaft and drive assembly into drive housing. Pins of drive must be snapped into holes of shift lever. Thrust collar must be in place before shaft is inserted in housing roller bearing.

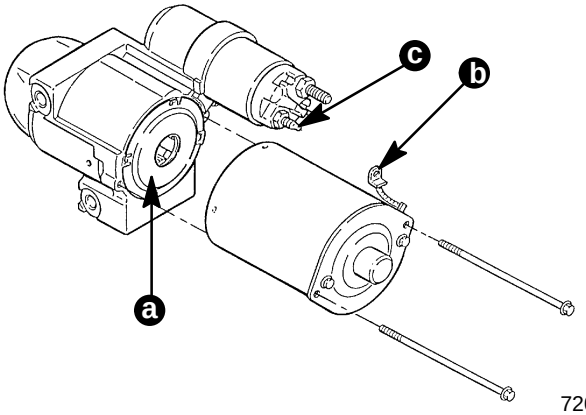


72628

72075

a - Pins of Drive
b - Holes of Shift Lever
c - Thrust Collar

8. Install shield. Align brush lead and solenoid terminal when inserting armature into planetary gears.

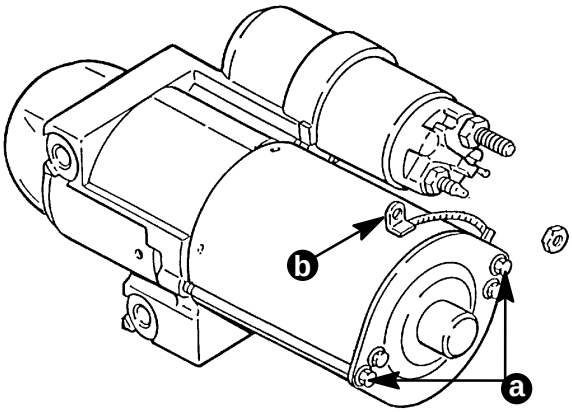


72061

a - Shield
b - Brush Lead
c - Solenoid Terminal

9. Install thru bolts and brush lead. Tighten fasteners securely.

IMPORTANT: Do not overtighten thru bolts. Overtightening will bend end frame.



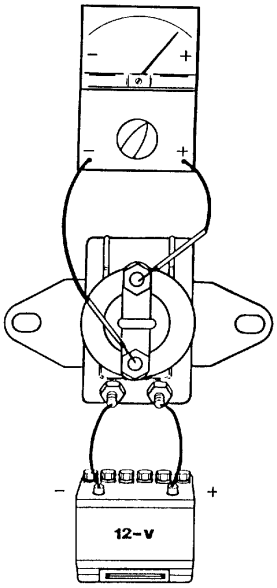
72060

a - Thru Bolts
b - Brush Lead

Standard Starter Slave Solenoid

Testing/Replacement

1. Using continuity meter, connect test leads as shown, and connect 12 volt battery with jumper leads as shown.



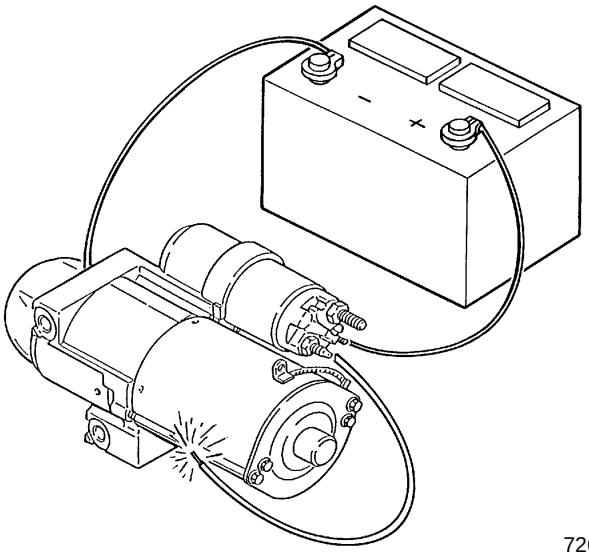
72630

a - Brush Lead

2. If no meter movement is present, replace solenoid.
3. Install thru bolts and brush lead. Tighten fasteners securely.

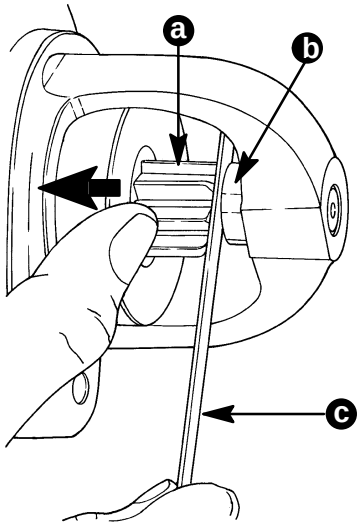
Index

4. Connect 12 volt battery positive (+) lead to solenoid switch terminal and negative (–) lead to solenoid frame.
5. Momentarily touch a jumper lead from solenoid motor to starter motor frame. This shifts pinion into cranking position where it will remain until battery is disconnected.



72629

6. Push pinion back toward commutator end to eliminate slack.
7. Measure distance between pinion and pinion retainer.
8. If clearance is not within limits of .010-.160 in. (0.25-4.00 mm), it may indicate excessive wear of solenoid linkage, shift lever yoke, or improper assembly of shift lever mechanism. Replace worn or defective parts, since no provision is made for adjusting pinion clearance.



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a - Pinion
b - Retainer
c - Feeler Gauge

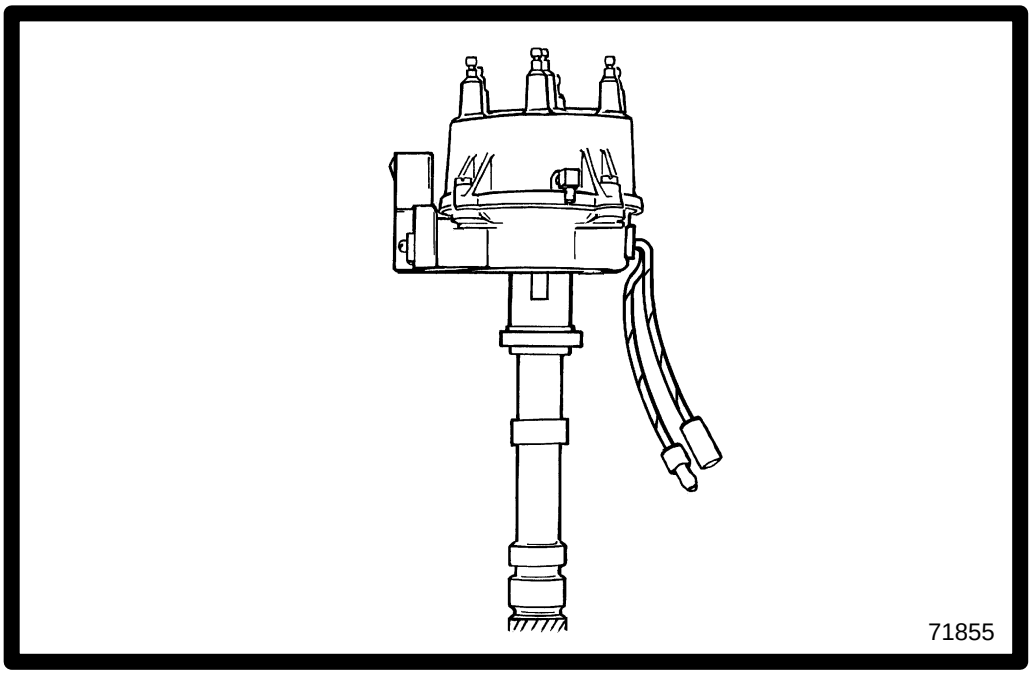
Installation

IMPORTANT: Install special mounting shim (if equipped) between starter motor and engine block.

1. Place starter motor in position and install mounting bolts. Torque bolts to 30 lb. ft. (41 N·m).
2. Connect YELLOW/RED wire to terminal S of solenoid. Connect ORANGE wire, RED wire, and battery cable to large terminal of solenoid. Tighten fasteners securely. Coat terminals with Quicksilver Liquid Neoprene. Install battery cable boot, if so equipped.
3. Connect battery cables to battery in the following order. Connect positive (+) cable to positive (+) battery terminal and tighten cable clamp. Then connect negative (–) cable to negative (–) terminal and tighten clamp.

Index

ELECTRICAL SYSTEMS



4

B

IGNITION SYSTEM

Index

Table of Contents

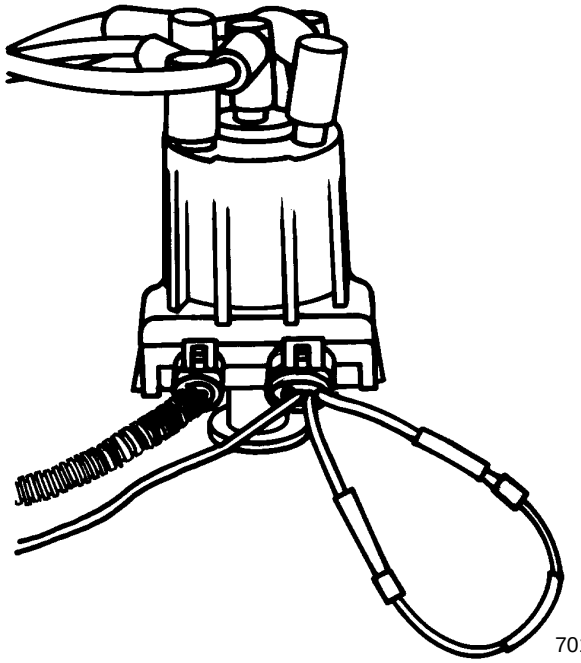
	Page
Identification	4B - 1
Replacement Parts Warning	4B - 2
Spark Plugs	4B - 2
Spark Plug Wires	4B - 2
3.0L Breaker Point Ignition Prestolite Distributor System	4B - 3
Torque Specifications	4B - 3
Tools/Lubricants/Sealants	4B - 3
Specifications	4B - 3
Coil	4B - 3
Distributor	4B - 3
Spark Plugs	4B - 3
Firing Order	4B - 3
Distributor Advance Curves	4B - 4
Precautions	4B - 5
Distributor Cap and Rotor	4B - 5
Contact Points	4B - 5
Replacement	4B - 6
Condenser	4B - 7
Coil	4B - 8
Ignition Resistance Wire	4B - 8
Distributor Repair	4B - 8
Removal	4B - 8
Disassembly	4B - 9
Reassembly	4B - 9
Distributor Installation	4B - 9
Engine Not Disturbed	4B - 9
Engine Disturbed	4B - 10
Ignition Timing	4B - 10

	Page
(DDIS) Digital Distributorless Ignition System	4B - 11
Specifications	4B - 11
Torque Specifications	4B - 11
Tools/Lubricants/Sealants	4B - 11
Spark Plugs	4B - 11
Overspeed Prevention Control	4B - 11
Description	4B - 12
DDIS System Components	4B - 12
Spark Advance Control	4B - 13
Advance Curve Chart (Reference Only)	4B - 13
MCM 3.0 L DDIS Models	4B - 13
Spark Advance Control	4B - 14
Advance Curve Chart (Reference Only)	4B - 14
MCM 3.0 LX (DDIS) Models	4B - 14
Components Tests	4B - 15
Ignition Amplifier	4B - 15
Ignition Coil	4B - 16
Motion Sensor	4B - 17
Shift Interrupter Switch	4B - 17
Motion Sensor	4B - 18
Removal	4B - 18
Installation	4B - 18
DDIS Ignition Timing	4B - 19
Delco EST Ignition	4B - 20
Torque Specifications	4B - 20
Tools/Lubricants/Sealants	4B - 20
Specifications	4B - 20
Spark Plugs	4B - 20
Component Tests	4B - 22
MCM 3.0L, 3.0LX with EST	4B - 23

NOTICE

For information and procedures on troubleshooting, refer to SECTION 1C.

Identification



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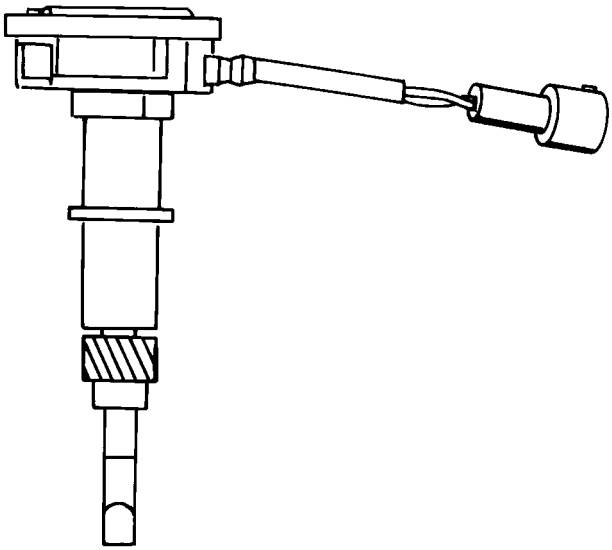
DELCO EST (ELECTRIC SPARK TIMING)



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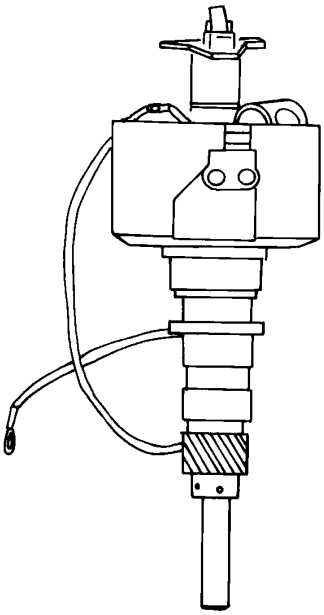
DIGITAL DISTRIBUTORLESS IGNITION SYSTEM (DDIS)



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BREAKER POINTS IGNITION

Replacement Parts Warning

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Index

3.0L Breaker Point Ignition Prestolite Distributor System

Torque Specifications

Fastener Location	Lb. Ft.	N•m
Distributor Clamp 3/8-16	20	27
Spark Plugs (14 mm)	15	20

Tools/Lubricants/Sealants

Mercury Marine Special Tools	
Description	**Part Number**
Dwell Meter	91-59339
Magneto Analyzer	91-76032
Remote Starter Switch	91-52024A1
Timing Light	91-99379
Volt/Ohm Meter	91-99750
Timing Jumper	91-818812A1

Kent-Moore Tools	
Description	**Part Number**
Module Tester	J24642

Specifications

Coil

Description	Specification
Coil Part Number	392-7803A4
Max. Operating Amps*	1.1
Primary Resistance	1.1-1.5 Ohms
Secondary Resistance	9.400 - 11.700 Ohms
Secondary Continuity*	67 - 77
Resistor Wire	1.8 - 2 Ohms

Distributor

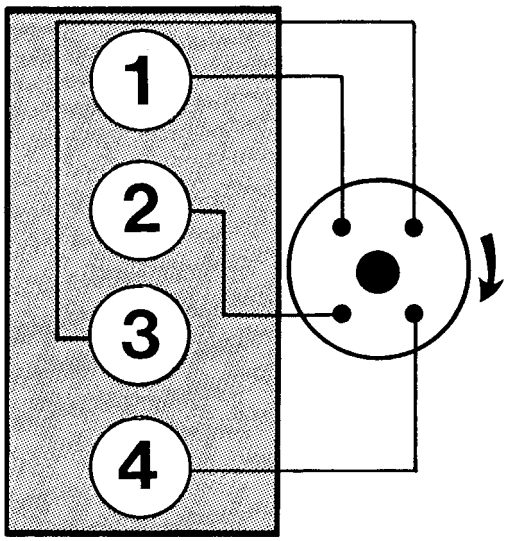
Model	3.0L
Condenser*	.18 - .25 mfd
Point Dwell	39° - 45°
Point Gap	.016 in. (0.5mm)
Point Spring Tension	20 - 27 oz. (567 - 765 g)
Timing	8° BTDC

NOTE: ** Use Magneto Analyzer*

Spark Plugs

Model	3.0L
Spark Plug Gap	.035 In. (0.9 mm)
Spark Plug Type	AC-MR43T NGK-BR6FS Champion RV15YC4

Firing Order



Firing Order 1-3-4-2

50683

Index

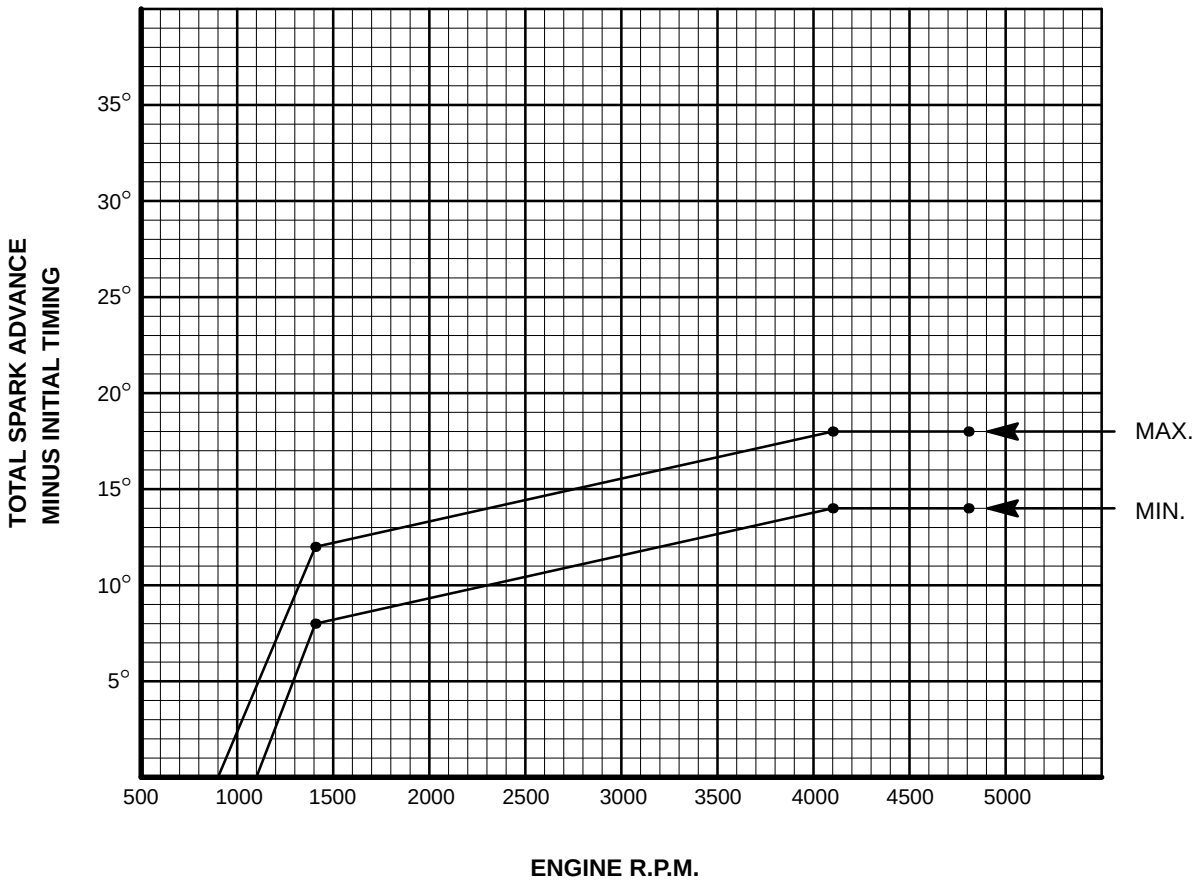
Distributor Advance Curves

MCM 3.0L with Prestolite Distributor

Distributor Advance: 16°
Initial Timing: 8° BTDC
Total Advance: 24° @ 4100 RPM
Point Gap: .016 in. (0.41 mm)
Point Dwell: 39° - 45°
Point Spring Tension: 20 -27 oz. (567 - 765 g)

IMPORTANT: Distributor advance curve charts do not include the initial engine timing. Basic initial timing must be added to chart for total advance curve.

IMPORTANT: The spark advance is controlled by the ignition module.



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Index

Precautions

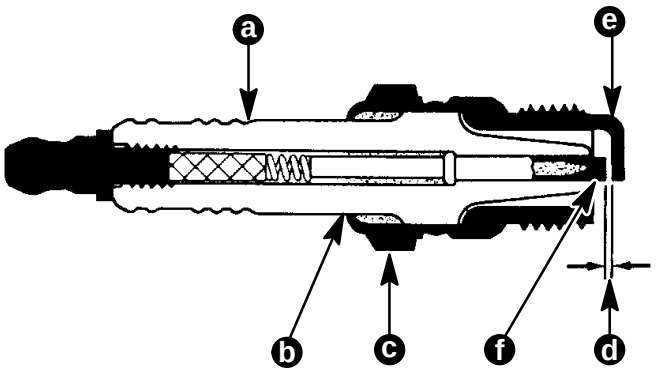
⚠WARNING

When performing the following procedure, be sure to observe the following:

- **Be sure that engine compartment is well ventilated and that no gasoline vapors are present, to avoid the possibility of fire.**
- **Be sure to keep hands, feet and clothing clear of moving parts.**
- **Do not touch or disconnect any ignition system parts while engine is running.**
- **Do not reverse battery cable connections. System is negative (–) ground.**
- **Do not disconnect battery cables while engine is running.**

Spark Plugs

1. Inspect each plug individually for badly worn electrodes, glazed, broken or blistered porcelain and replace plug where necessary.
2. Inspect each spark plug for make and heat range. All plugs must be the same make and number or heat range. Refer to “Specifications” for spark plug numbers.
3. Adjust spark plug gaps with a round feeler gauge.



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Spark Plug Detail

a - Porcelain Insulator
b - Check For Cracks In This Area of Porcelain
c - Shell
d - Proper Gap
e - Side Electrode (Bend to Adjust Gap)
f - Center Electrode (File Flat When Adjusting Gap) - Do Not Bend

IMPORTANT: Tapered seat spark plugs are not interchangeable with non-tapered (with gasket) spark plugs.

4. Clean spark plug seating area. DO NOT use gaskets on taper seat plugs. Install spark plugs and torque to 15 lb. ft. (20 N·m.). Heat transfer and a gas-tight seal must be achieved.

Spark Plug Wires

1. Inspect spark plug wires for damage.
2. Check spark plug wires for continuity.
3. Replace any wires that are cracked, cut, or have damaged spark plug boots.
4. Replace any wires that do not show continuity from end to end.
5. Reinstall spark plug wires in proper order.

IMPORTANT: Proper positioning in spark plug wires is important to prevent cross firing.

Distributor Cap and Rotor

6. Loosen distributor cap retaining screws.
7. Remove distributor cap.
8. Clean cap with warm soap and water and blow off with compressed air.
9. Check cap contact for excessive burning or corrosion. Check center contact for deterioration.

IMPORTANT: Distributor caps (for marine use) should have brass contacts, aluminum contacts should not be used.

10. Check cap for cracks or carbon tracks using magneto analyzer.
11. Remove rotor.
12. Check for burned or corroded center contact.
13. Check rotor for cracks and carbon tracks using magneto analyzer.
14. Install rotor on shaft. Be sure rotor is completely seated on shaft.
15. Place cap on distributor.
16. Tighten retaining screws securely.

Index

Contact Points

1. Examine contact points for dirt, wear, pitting and misalignment. Dirty points should be cleaned. Normal point condition is an overall grey color on contact surface.
2. Check for point resistance. A voltage drop of less than .125 volts across points should exist. Make this check with a sensitive volt meter or point resistance meter.

ABNORMAL POINT WEAR

1. Points, which have been operated for period of time, have a rough surface, but this may not mean that points are worn out.
2. If points burn or pit, however, they soon become unsatisfactory for further operation. Not only must they be replaced, but ignition system and engine must be checked to determine cause and elimination of trouble. Unless condition is corrected, new points will provide no better service than old points.

CLEANING POINTS

1. Dirty contact points should be dressed with a few strokes of a clean, fine -cut contact file. File should not be used on other metals and should not be allowed to become greasy or dirty.

IMPORTANT: Never use emery cloth to clean contact points.

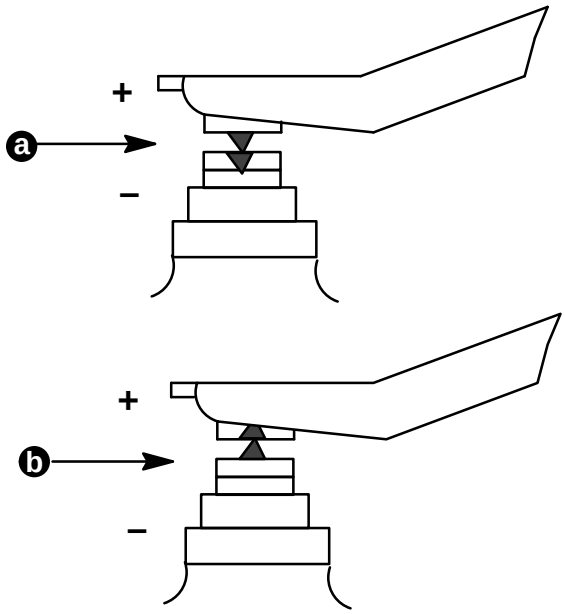
2. Contact surfaces, after considerable use, may not appear bright and smooth, but this is not necessarily an indication that they are not functioning satisfactorily. Do not attempt to remove all roughness nor dress point satisfactorily. Do not attempt to remove all roughness nor dress point surfaces down smooth. Merely remove scale or dirt.
3. Badly burned or pitted contact points should be replaced and cause of trouble determined and corrected.

BURNED POINTS

1. Contact point burning results from high voltage, presence of oil or other foreign material, defective condenser and improper point adjustment.
2. High voltage causes excessively high current flow thru contact points which burns them rapidly. High voltage can result from improperly adjusted or inoperative voltage regulator.
3. Oil or crankcase vapors, which work up into distributor and deposit on point surfaces, cause them to burn rapidly.
4. If contact point opening is too small (cam angle too large), points will be closed too long. Average current flow thru points will be too high, so points will burn rapidly and arcing will occur between points.
5. High series resistance in condenser circuit will prevent normal condenser action, so contact points will burn rapidly. This resistance may be caused by a loose condenser mounting or lead connection, or by poor connections inside condenser.

PITTED POINTS

1. Contact point pitting results from an out-of-balance condition in ignition system which causes transfer of material from one point to other so that a tip builds up on one point while a pit forms in other.



Material Transfer

a - Negative to Positive
b - Positive to Negative

2. If points are pitted, replace condenser (and points).

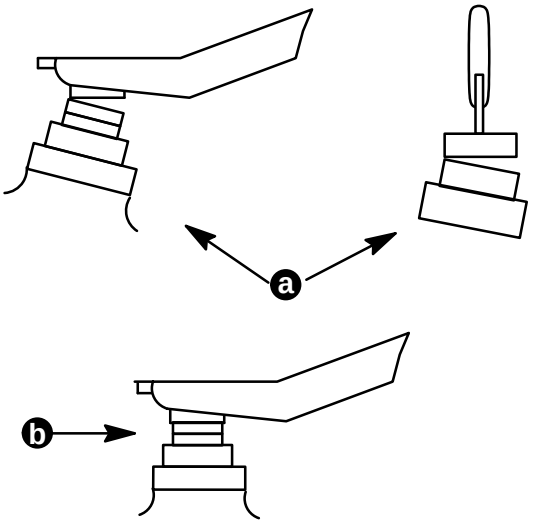
Index

Replacement

1. Remove primary and condenser lead wires from contact point terminal.
2. Remove contact set attaching screw and lift contact point set from breaker plate.
3. Clean oil smudge and dirt from breaker plate.

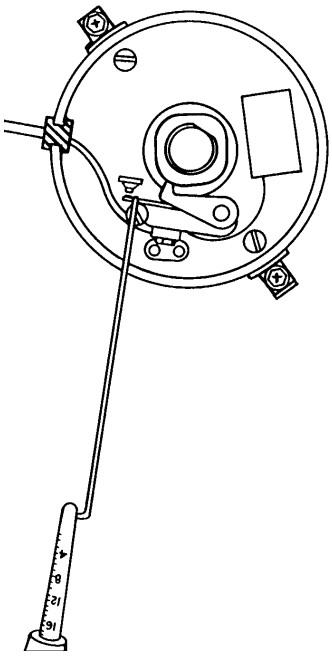
IMPORTANT: Carefully wipe protective film from point set prior to installation.

4. Place a small amount of Distributor Cam Lubricant on distributor cam.
5. Place new contact point assembly in position on breaker plate and install attaching screw.
6. Check points for proper alignment. If points do not align properly, replace with another set of points.



a - Lateral Misalignment
b - Proper Lateral Alignment

7. Connect primary and condenser lead wires to terminal on contact point set.
8. Check point spring tension (20-27 oz.) 567-765g.



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a - Movable Contact
b - Spring Tension Gauge

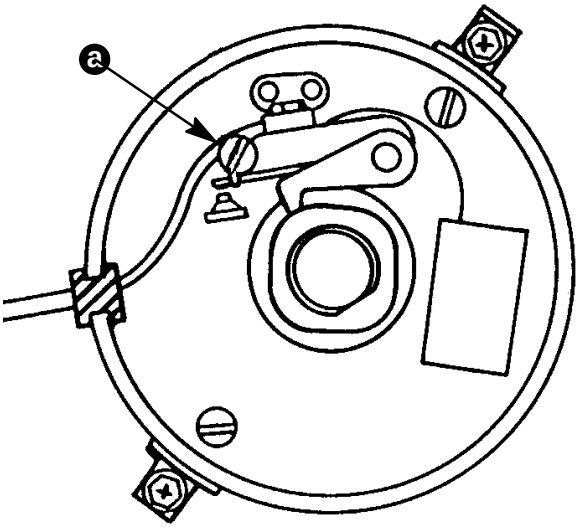
Contact point pressure must fall within specified limits (Step 8, preceding). Weak tension will cause chatter which results in arcing and burning of points and an ignition miss at high speed, while excessive tension will cause undue wear of contact points, cam and rubbing block. Contact point pressure should be checked with a spring gauge. Scale should be hooked to breaker lever, and pull exerted at 90° to breaker level. Reading should be taken just as points separate. Pressure can be adjusted by bending breaker level spring. If pressure is excessive, it can be decreased by pinching spring carefully. To increase pressure, remove lever from distributor so that spring can be bent away from lever. Avoid excessive spring distortion.

IMPORTANT: Point gap or (dwell) can be adjusted by 2 methods. It is preferred that points be adjusted with a feeler gauge, then checked with a dwell meter. Points, however, also can be adjusted, as well as checked, with a dwell meter: After points have been set, dwell should be checked with engine running.

Index

POINT ADJUSTMENT WITH FEELER GAUGES

1. Rotate distributor until rubbing block rests on peak of cam lobe, which will provide maximum breaker point opening.
2. Insert correct feeler gauge between breaker points.
3. Loosen lock screw and adjust points to .016 in. (0.5mm).



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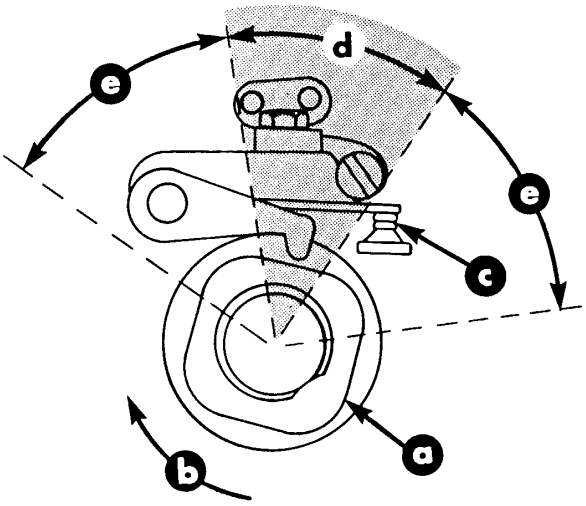
a - Lock Screw

DWELL ADJUSTMENT

1. Remove distributor cap and rotor.
2. Connect positive (+) dwell meter lead to negative (–) side of coil. Connect negative (–) meter lead to ground.
3. Loosen point lock screw slightly.
4. While cranking engine with starter, adjust dwell with a screwdriver to obtain reading on dwell meter, as specified in “Specifications”, and tighten lock screw. (Dwell reading will be unsteady using this method.)

IMPORTANT: Cam angle increases as point opening is decreased and vice versa.



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Cam Angle

a - Cam
b - Direction or Rotation
c - Breaker Points
d - Dwell (In Degrees When Points Are Closed)
e - Points Open

5. Install rotor and distributor cap and recheck dwell with engine running.

IMPORTANT: Dwell should be checked between idle and 1750 RPM. Any dwell reading variations of more than 3° between idle and 1750 RPM would indicate wear in the distributor. Cam angle readings, taken at speeds above 1750 engine RPM, may prove unreliable on some dwell meters.

Index

Condenser

1. Use Magneto Analyzer for test.
2. Test condenser for the following:
   a. Condenser capacity test (.18-.25 mfd).
   b. Condenser leakage and short test.
   c. Condenser series resistance test.
3. Replace condenser if test results are not within specifications.

Coil

1. Use Magneto Analyzer for test.
2. Check coil for the following:
   a. Coil power test.
   b. Coil surface insulation test.
   c. Coil continuity test.
   d. Primary resistance test.
   e. Secondary resistance.
3. Replace coil if test results are not within specifications.

Ignition Resistance Wire

(ELECTRIC CHOKE)

1. Disconnect wire from positive (+) side of coil.
2. Unplug quick disconnect (with 2 wires) from electric choke heater element.
3. Connect ohmmeter leads to ends of disconnected wire. Replace resistor wire if reading is not within specifications.
4. Reconnect wires to coil and choke.
5. **Breaker Point Ignition Models**: For instructions on replacing resistor wire, refer to “Section 4, Part E”.

Distributor Repair

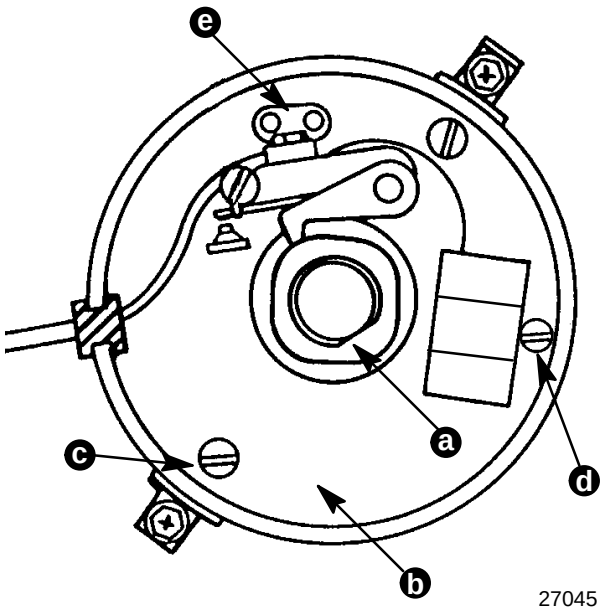
Removal

1. Disconnect distributor primary lead from coil terminal.
2. Remove distributor cap and rotor.

IMPORTANT: If necessary to remove leads from distributor cap, mark position on cap tower for lead to number 1 cylinder. This will aid in installation of leads in cap.

3. Scribe a realignment mark on distributor in line with rotor notch (located on distributor shaft).
4. Mark distributor housing in reference to engine block.
5. Remove bolt and hold-down clamp and remove distributor.

IMPORTANT: Avoid rotating engine with distributor removed, as ignition timing will be upset.



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Breaker Plate And Attaching Parts

a - Rotor Alignment ”Flat”
b - Breaker Plate
c-Breaker Point Attaching Screw
d - Condenser Bracket With Screw
e-Wire Terminal With Screw

Index

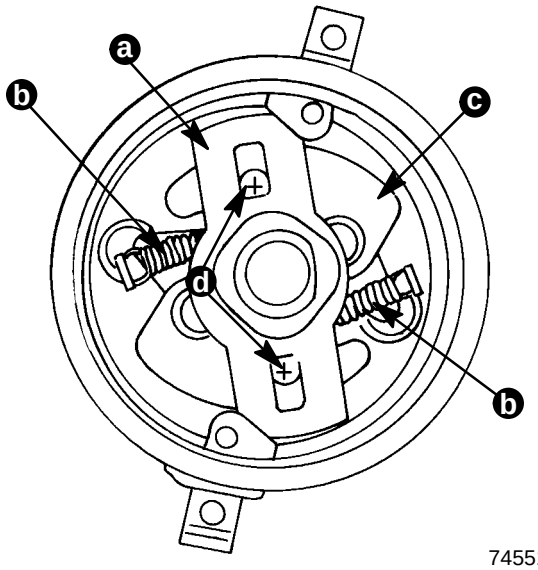
Disassembly

IMPORTANT: It is not necessary to disassemble distributor any further than required to complete repairs.

1. Remove condenser and breaker points from breaker plate. Test condenser and check breaker points.
2. Remove breaker plate from distributor housing. Excessive oil on breaker plate assembly would indicate a bad oil seal in distributor housing.

IMPORTANT: Main shaft bushings and oil seal in housing are not serviced separately. Housing, bushings and oil seal are serviced as complete assembly.

3. Remove roll pin retaining driven gear to main shaft and slide gear from shaft.
4. Check for side play between main shaft and bushings in distributor housing. Maximum side play allowed is .002 in. (0.05 mm).
5. Remove shaft from housing and check shaft for being bent with a dial indicator and V-blocks. Maximum runout is .002 in. (0.5 mm).
6. Remove weight cover, check weights and weight stop for wear. Check weights for free movement on pins.



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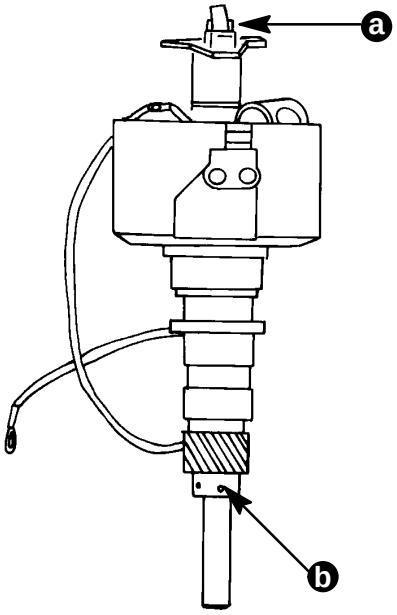
a - Weight Cover
b - Weight Springs
c - Weights
d - Weight Stop Studs

Index

Advance Weights and Components

Reassembly

1. Replace centrifugal advance, as necessary.
2. Lubricate shaft with engine oil. Install main shaft in distributor housing.
3. Install driven gear on main shaft.
4. Line up mark on driven gear with rotor tip on main shaft.
5. Install roll pin through gear and main shaft.
6. Install breaker plate on distributor housing.
7. Install condenser and breaker points on breaker plate.
8. Install rotor.
9. Install distributor as outlined in ”Distributor Installation ” following.



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Gear Installation

a - Rotor Contact
b - Gear Alignment Mark

Distributor Installation

Engine Not Disturbed

1. Install new gasket on distributor housing.
2. Turn rotor approximately 1/8 turn in a counter-clockwise direction past mark previously scratched on distributor housing.
3. Work distributor down into position in engine block with distributor positioned as noted during removal.

IMPORTANT: It may be necessary to move rotor slightly to start gear into mesh camshaft gear, but rotor should line up with mark when distributor is down in place. Distributor shaft must enter oil pump shaft for complete installation.

4. Replace and tighten distributor hold-down bolt and clamp. Connect primary lead to coil. Also install spark plug and coil secondary wires , if removed.

IMPORTANT: Wires must be installed in supports, to prevent cross-firing. Firing order is 1-3-4-2.

5. Set points gap to .016 in (0.5 mm).
6. Install rotor
7. Check dwell (39- 45 degrees)
8. Time ignition as outlined under ”IGNITION TIMING”.

Engine Disturbed

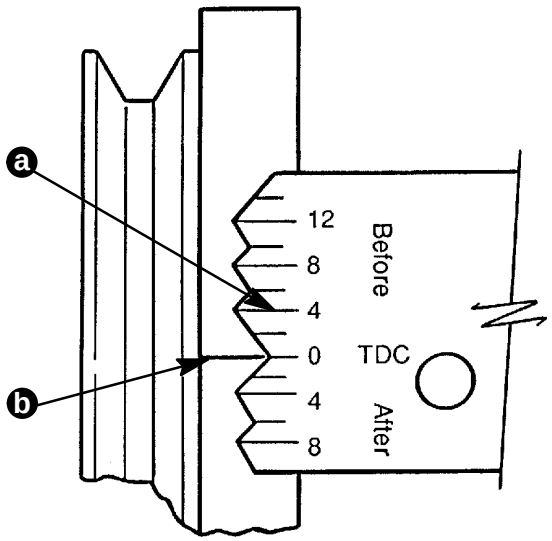
1. Locate No. 1 piston in firing position by either of two methods described below.
   a. Remove No. 1 spark plug and, with finger on plug hole, crank engine until compression is felt in No. 1 cylinder. Continue cranking until pointer lines up with timing mark on crankshaft pulley, or
   b. Remove rocker cover and crank engine until No. 1 intake valve closes, continuing to crank slowly until pointer lines up with timing mark on crankshaft pulley.
2. Position distributor to opening in block in normal installed attitude.
3. Position rotor to point toward front of engine (with distributor housing held in installed attitude), then turn rotor counterclockwise approximately 1/8-turn more to the left and push distributor down to engage camshaft. It may be necessary to rotate rotor slightly until camshaft engagement is felt.
4. While pressing down firmly on distributor housing, engage starter a few times to make sure oil pump shaft is engaged. Install hold-down clamp and bolt and snug up bolt.
5. Turn distributor body slightly until points just open and tighten distributor clamp bolt.
6. Place distributor cap in position and check that rotor lines up with terminal for No. 1 spark plug. Install cap.
7. Install cap, distributor primary lead to coil. Check and connect spark plug wires, if they have been removed. Wires must be installed in their proper location in supports to prevent cross-firing. Firing order is 1-3-4-2.
8. Set points gap to .016 in (0.5 mm).
9. Install rotor
10. Check dwell (39- 45 degrees)
11. Time ignition as outlined under ”ignition Timing”.

Ignition Timing

1. Connect timing light to No. 1 spark plug. Connect power supply leads on light to 12 volt battery. Refer to “Specifications” for cylinder numbering and location.
2. Connect tachometer to engine.
3. Start engine and run at normal idle speed.
4. Aim timing light at timing tab, located on timing gear cover and crankshaft torsional damper.

Index

IMPORTANT: GM engine timing marks (on tab) are in 2-degree increments. Timing must be set on the "before" side of "0" (Top Dead Center).



a - Degree Marks
b - Timing Mark

5. Adjust timing by loosening distributor clamp and rotating distributor body as required until timing mark on damper or pulley lines up with the mark on tab specified in "Specifications." Tighten clamp and recheck location of timing mark.
6. Stop engine and remove timing light.

Index

(DDIS) Digital Distributorless Ignition System

Specifications

COIL

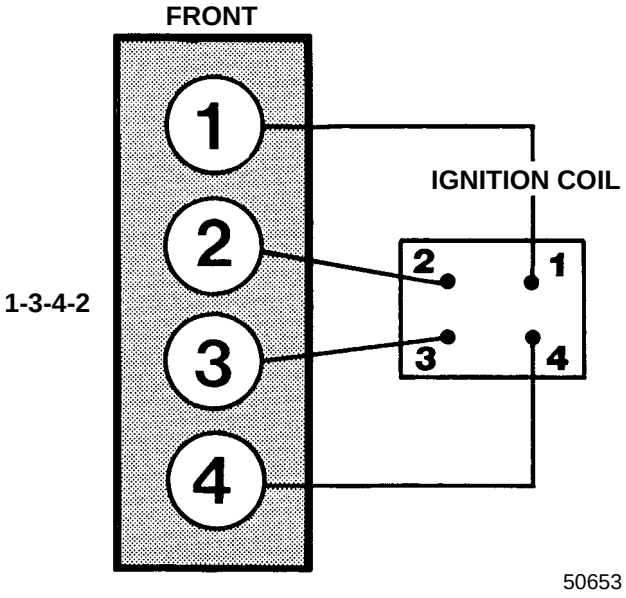
Description	Specification
Primary Resistance	1.9-2.5 Ohms *1
Secondary Resistance	11.3 - 15.5 Ohms *2

* At Room Temperature 68° F (20° C)
1 Ohmmeter scale Rx1
2 Ohmmeter scale Rx1000

IGNITION TIMING

Timing	8° BTDC at 700 RPM

FIRING ORDER



Torque Specifications

Fastener Location	In. Ft.	Lb. Ft.	N·m
Motion Sensor Clamp 3/8-16		20	27
Ignition Amplifier	65		7.3
Ignition coils	20		2.2
Spark Plugs (14 mm)		15	20

Tools/Lubricants/Sealants

Mercury Marine Special Tools	
Description	**Part Number**
Dwell Meter	91-59339
Magneto Analyzer	91-76032
Remote Starter Switch	91-52024A1
Timing Light	91-99379
Volt/Ohm Meter	91-99750
Timing Jumper	91-818812A1

Spark Plugs

Spark Plug Gap	.035 In. (0.9 mm)
3.0L (DDIS)	AC-MR43T NGK-BR6FS Champion RV15YC4
3.0LX (DDIS)	AC-MR43LTS NGK-BPR6EFS Champion RS12YC

Overspeed Prevention Control

CONTROL MODULE FUNCTION SPECIFICATIONS

ENGINE SPEED (RPM)	SPARK CONTROL FUNCTION
4750	Normal Spark
5050	Misfires - Intermittent Spark
5150	Spark Shuts OFF, completely

NOTE: *Refer to SECTION 1-C for troubleshooting*

Index

Description

The Digital Distributorless Ignitions System (DDIS) replaces the conventional point style ignition system.

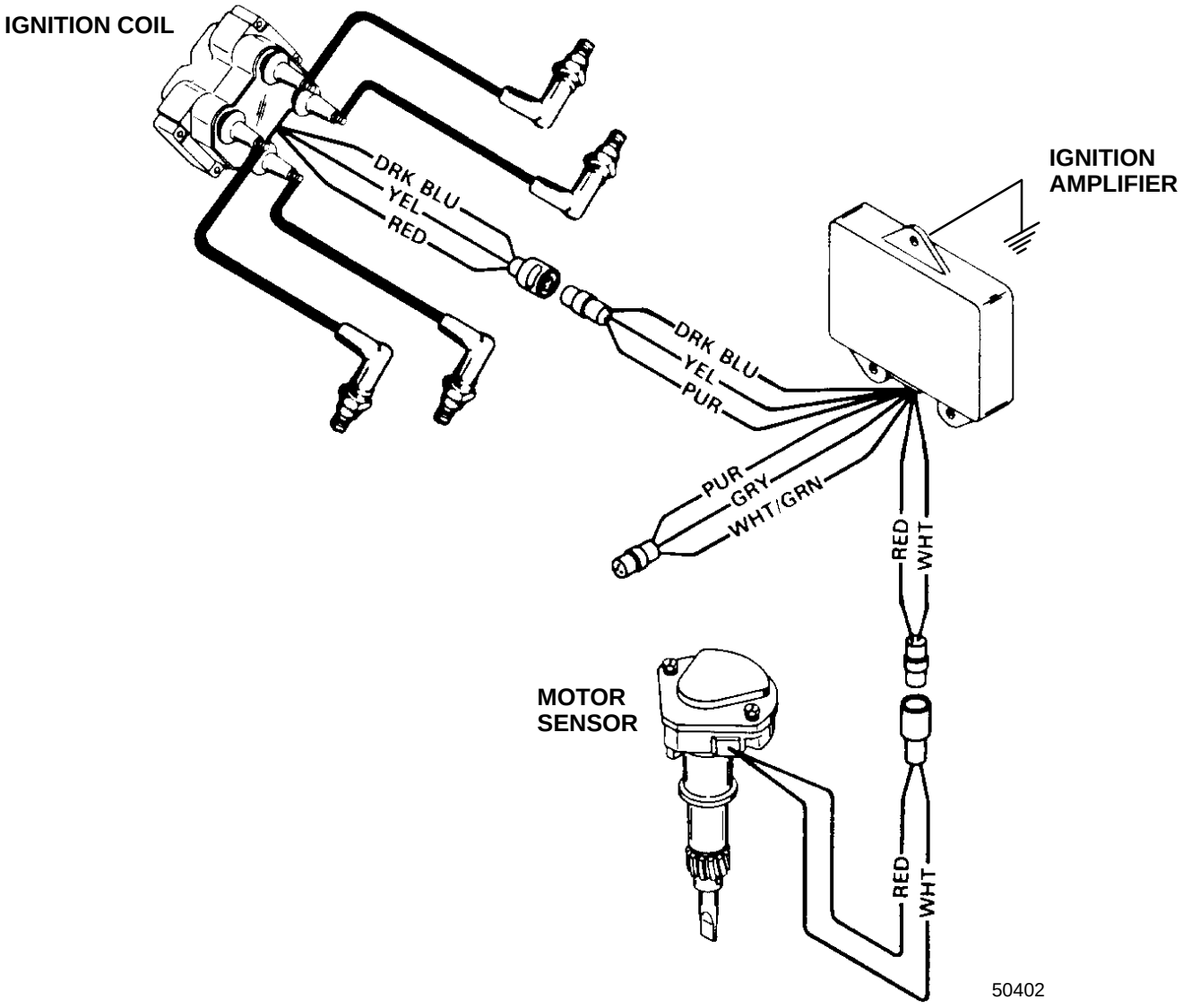
A motion sensor replaces the conventional distributor and senses crankshaft position.

The ignition amplifier controls coil output, spark advance, and limits engine speed to approximately 5000 RPM.

The ignition coil is actually two coils in one with four high voltage towers. The coils are fired on both compression stroke and exhaust stroke.

DDIS System Components

MCM 3.0L/3.0LX Models



IMPORTANT: Models equipped with Digital Distributorless Ignition System (D.D.I.S.) have an overspeed prevention control built into the system. The control module limits engine speed to 5000 RPM, when speed exceeds 5000 RPM, the control misfires ignition spark and continues to slow down engine until engine speed drops below 4800 RPM.

When the engine exceeds 5100 RPM, primary pulses to the ignition coil stop until engine speed drops below 5000 RPM.

Index

Spark Advance Control

IMPORTANT: The ignition amplifier controls spark advance above 1000 RPM. There is no adjustment. Initial timing must be set below 1000 RPM.

NOTE: *Many timing lights are inaccurate at high engine speeds; therefore, timing should not be adjusted above 1000 RPM.*

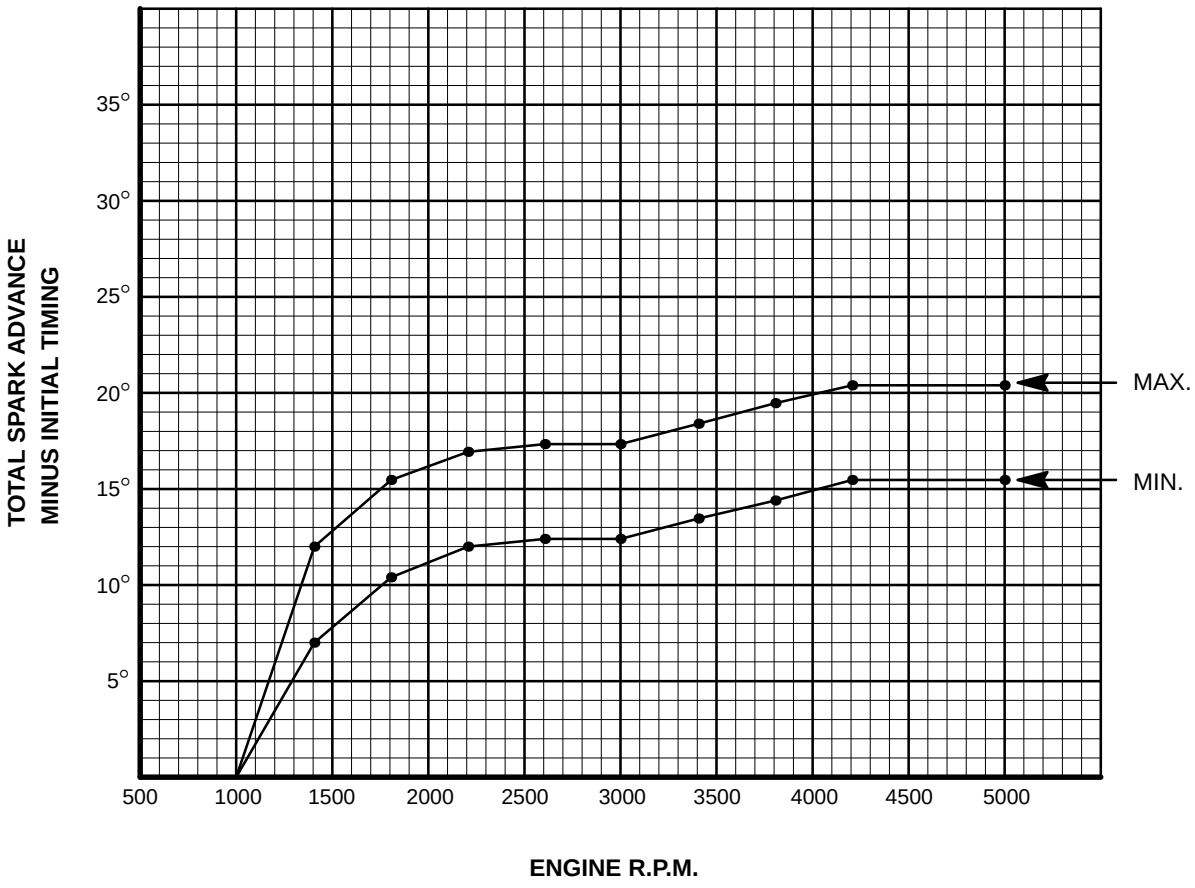
Module Part Number: 18811T1
Module Advance: 18°
Initial Timing: 8° BTDC
Total Advance: 26°

Advance Curve Chart (Reference Only)

IMPORTANT: Advance curve charts do not include the initial engine timing. Basic initial timing must be added to chart for total advance curve.

EXAMPLE: Advance curve chart shows 13° spark advance at 2000 RPM. Add 8° BTDC initial timing for a total spark advance of 21° at 2000 RPM.

MCM 3.0 L DDIS MODELS



70808-4

Index

Spark Advance Control

IMPORTANT: The ignition amplifier controls spark advance above 1000 RPM. There is no adjustment. Initial timing must be set below 1000 RPM.

NOTE: *Many timing lights are inaccurate at high engine speeds; therefore, timing should not be adjusted above 1000 RPM.*

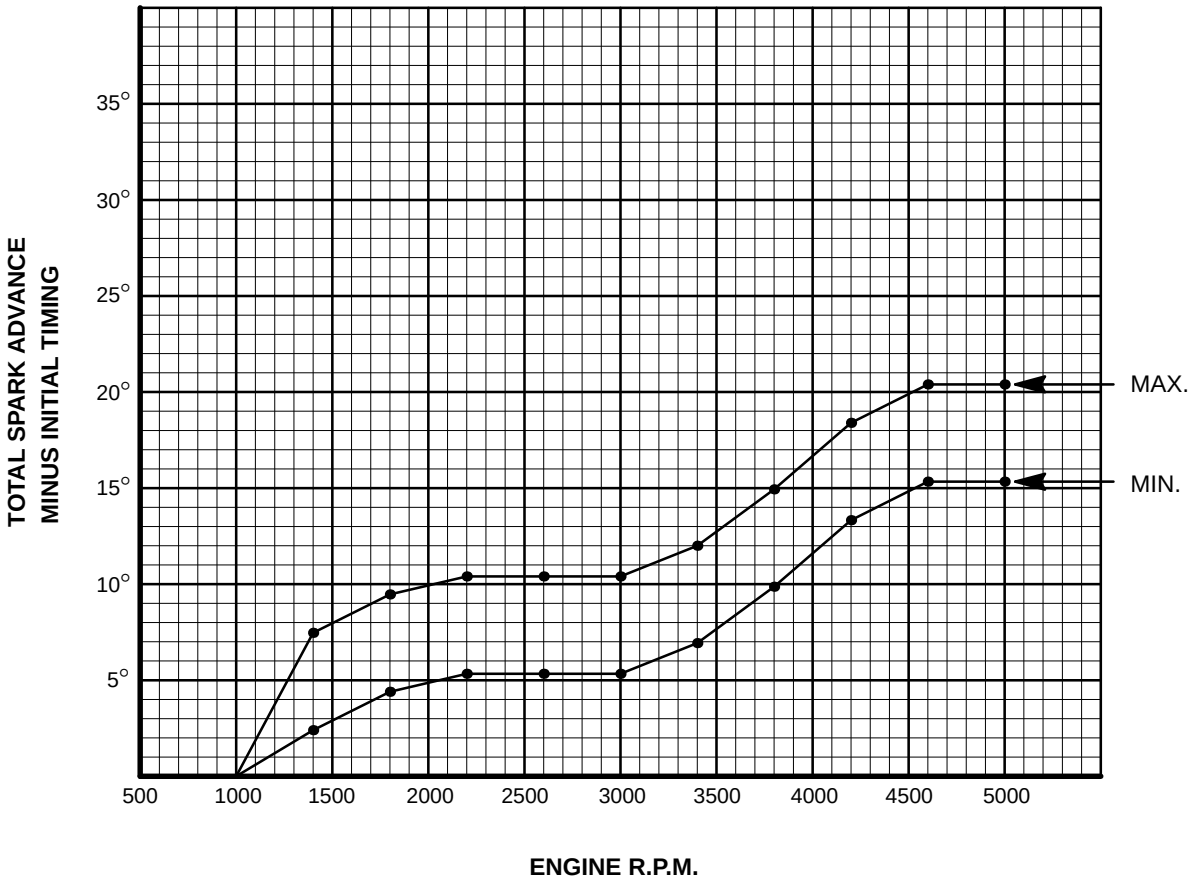
Module Part Number: 18811T2
Module Advance: 18°
Initial Timing: 8° BTDC
Total Advance: 26°

Advance Curve Chart (Reference Only)

IMPORTANT: Advance curve charts do not include the initial engine timing. Basic initial timing must be added to chart for total advance curve.

EXAMPLE: Advance curve chart shows 8° spark advance at 2000 RPM. Add 8° BTDC initial timing for a total spark advance of 16° at 2000 RPM.

MCM 3.0 LX (DDIS) MODELS



70808-5

Index

Components Tests

IMPORTANT: Check spark plugs and spark plug wires before the DDIS system. Use Multi-Meter 91-99750 to test DDIS components.

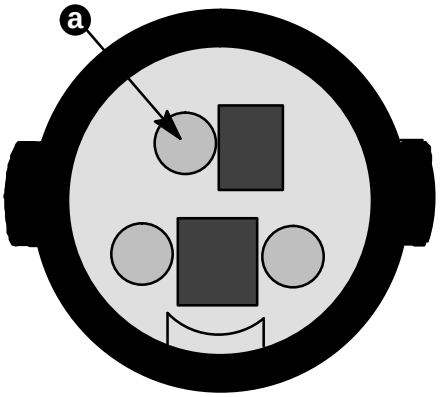
⚠WARNING

When performing the following procedures, be sure to observe the following:

- **Be sure that engine compartment is well ventilated and that no gasoline vapors are present, to avoid the possibility of fire.**
- **Be sure to keep hands, feet, and clothing clear of moving engine parts.**
- **Do not touch or disconnect any ignition system parts while engine is running.**
- **Do not reverse battery cable connections. System is negative (–) ground.**
- **Do not disconnect battery cables while engine is running.**

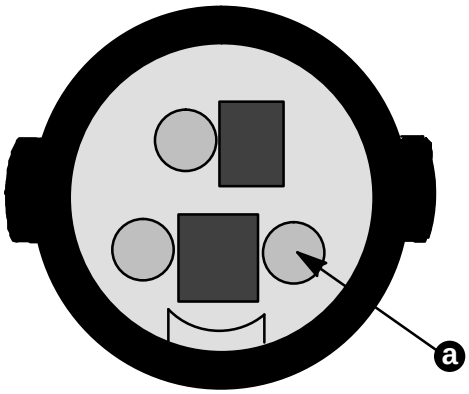
Ignition Amplifier

1. Disconnect ignition amplifier form coil. With the ignition switch in the “RUN” position, check voltage at terminal from ignition amplifier. Reading should be battery voltage.



a - Check Voltage Here

2. Disconnect engine harness form ignition amplifier. With ignition switch in the “RUN” position, check voltage at terminal from engine harness. Reading should be battery voltage.



a - Check Voltage Here

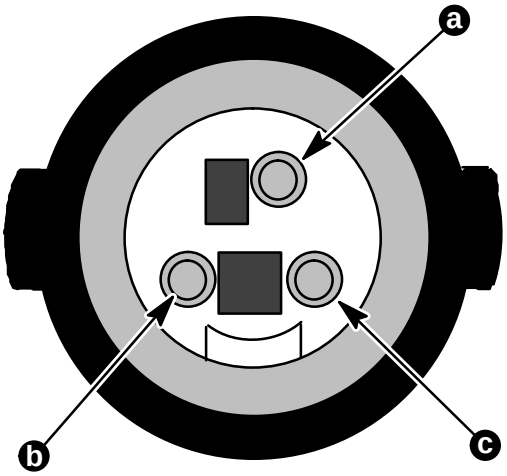
3. If voltage readings in steps one and two differ more than approximately 1/2 volt, ignition amplifier is defective.

Index

Ignition Coil

NOTE: *Ignition switch must be in the "OFF" position when testing ignition coil.*

1. Primary coil resistance:
   a. Disconnect coil from ignition amplifier.
   b. Measure resistance between coil connector terminals as shown.

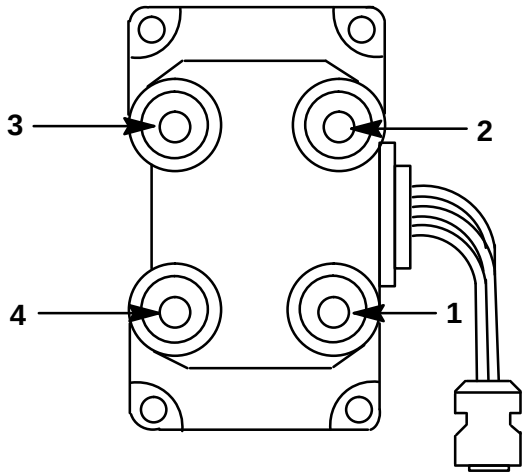


a - Check Resistance From "a" to "b"
b - Check Resistance From "b" to "c"

TERMINALS	RESISTANCE RANGE
a to b	1.9 - 2.5 Ohms * 1
a to c	

* At Room Temperature 68° F (20° C)
1 Ohmmeter set on the Rx1 Scale

2. Secondary coil resistance:
   a. Disconnect spark plug wires from coil high voltage towers.
   b. Measure resistance between towers as shown.

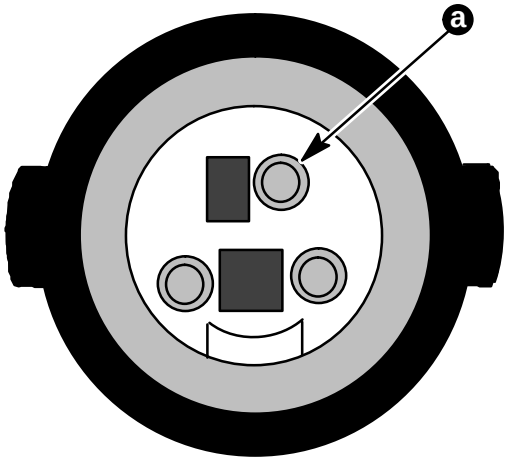


74672

* At Room Temperature 68° F (20° C)
1 Ohmmeter set on the Rx1000 Scale

HIGH VOLTAGE TOWERS	RESISTANCE RANGE
1 to 4	11.3 - 15.5 Ohms * 1
2 to 3	

3. Coil insulation resistance:
   a. Measure resistance between coil connector terminal and engine ground. Minimum resistance - 10 megohms.



a - Measure Resistance Between Here and Ground

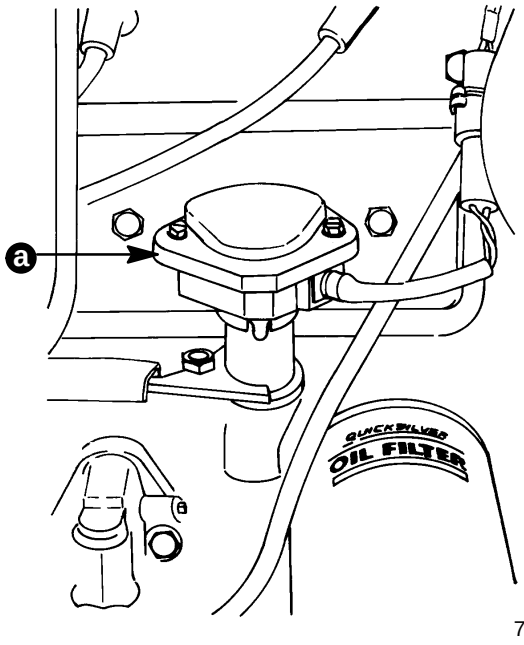
Index

b. Measure resistance between each high voltage tower and engine ground. Minimum resistance - 10 megohms.

Motion Sensor

NOTE: *Motion sensor is factory set and not adjustable.*

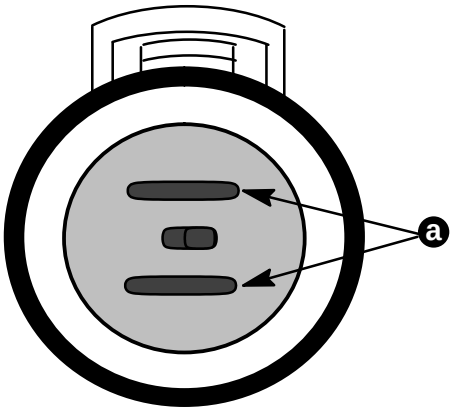
IMPORTANT: Do not remove cover unless it is damaged. There are no serviceable parts inside the motion sensor. Replace entire unit if defective.



Motion Sensor

1. With ignition switch in the “OFF” position, disconnect motion sensor from ignition amplifier. Measure resistance between sensor terminals. Resistance range - 140 to 180 ohms. (Rx10) If resistance is not within specifications, replace motion sensor.

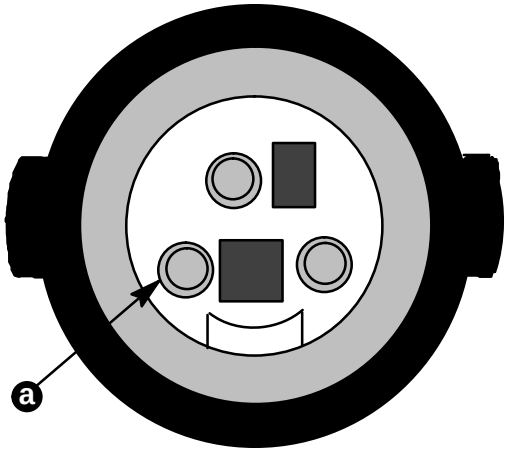
IMPORTANT: Motion sensor must be at room temperature, 68◦ F (20◦ C), when testing.



a - Check Resistance Between These Two Points

Shift Interrupter Switch

1. Disconnect ignition amplifier from engine harness. Check for continuity between harness connector (a) and engine ground. Switch is normally open. When shifting out of forward or reverse, switch will close momentarily.



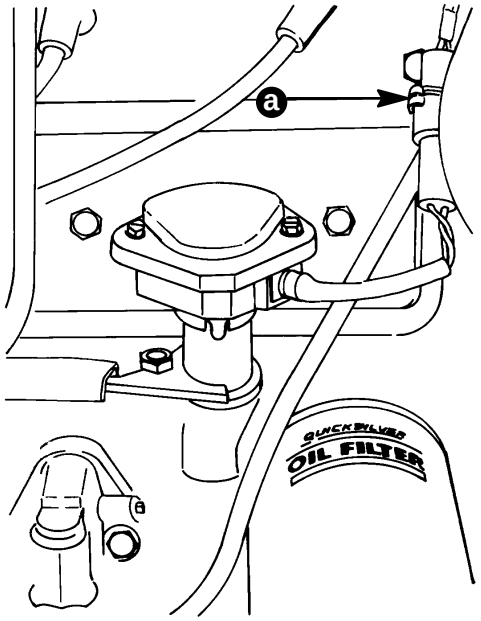
a - Check For Continuity From Here To Ground

Index

Motion Sensor

Removal

1. Disconnect wires (a).



74537

a - Wires

2. Crank engine until timing mark is on zero.
3. Remove motion sensor.

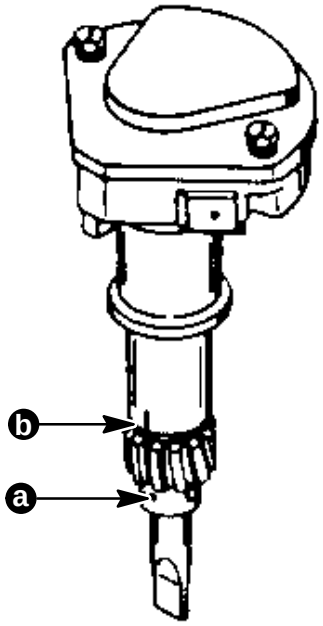
IMPORTANT: To simplify motion sensor reinstallation, do not turn crankshaft with motion sensor removed from engine.

Installation

IMPORTANT: After installation, apply Liquid Neoprene to all mounting fasteners and ground wires of the ignition amplifier and ignition coil.

NOTE: *The DDIS signals the coil to fire on both compression and exhaust strokes. To install the motion sensor, number one piston does not have to be TDC of its compression stroke. Simply align the timing mark on zero.*

1. Crank engine until timing mark is on zero.
2. Align hole [not roll pin hole] in gear with notch on motion sensor housing. Install new gasket. Apply Quicksilver 2-4-C Marine Lubricant with Teflon to gear.

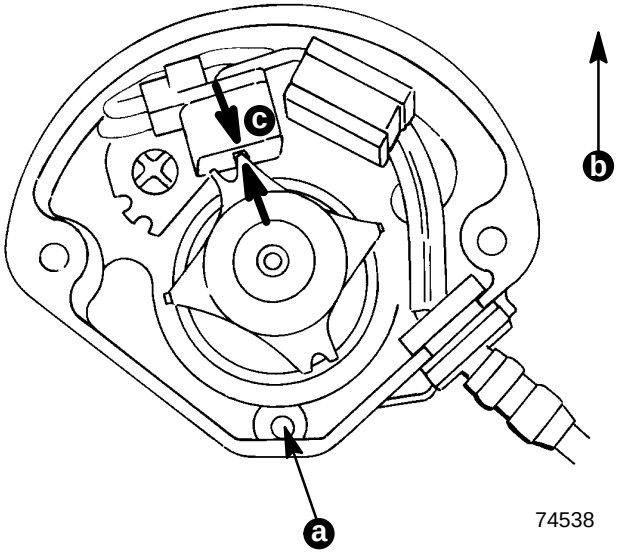


74390

a - Hole
b - Notch in Motion Sensor Housing

NOTE: *When installing motion sensor it may be necessary to turn oil pump drive shaft for alignment with motion sensor drive shaft.*

3. Remove motion sensor cover. Install motion sensor so drain hole is opposite engine block and sensor is aligned as shown.

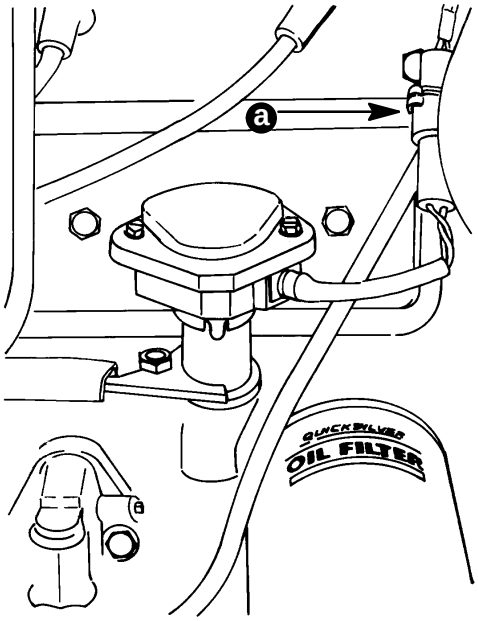


74538

a - Drain Hole
b - Toward Engine Block
c - Align These

Index

4. Reinstall cover. Tighten screws securely.
5. Connect wires.



26549

a - Connect Wires

DDIS Ignition Timing

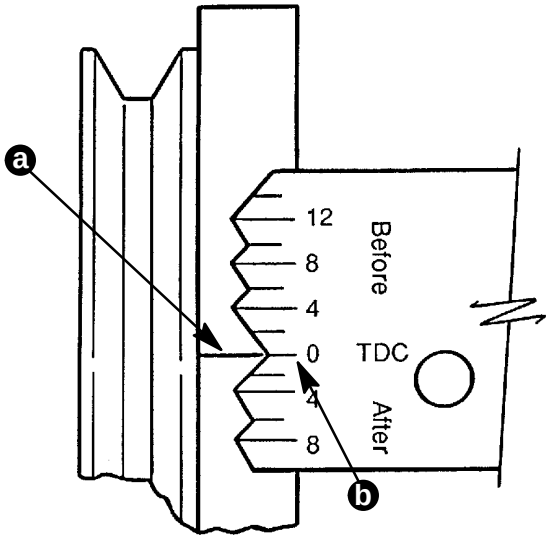
1. Connect timing light to No.1 spark plug. Connect power supply leads on light to battery.

⚠CAUTION

If the following procedure is performed out of water, a water source must be supplied to the water intake openings in gear housing.

2. Start engine and run at normal idle speed (under 900 RPM - use tachometer in boat instrumentation).
3. Adjust timing by loosening clamp and rotating motion sensor, as required, until timing mark on pulley aligns with 8° BTDC mark on tab. Torque clamp bolt to 20 lb. ft. (27 N·m) , and recheck location of timing mark.
4. Stop engine and disconnect timing light.

IMPORTANT: GM engine timing marks (on tab) are in 2° increments. Timing must be set on the "BEFORE" (Advance) side of "0" (Top Dead Center).



72328

Timing Marks on GM 4-Cylinder Engines

a - Timing Mark
b - Degree Marks

Index

Delco EST Ignition

Torque Specifications

Fastener Location	Lb. Ft.	N•m
Distributor Clamp 3/8-16	20	27
Spark Plugs (14 mm)	15	20

Tools/Lubricants/Sealants

Mercury Marine Special Tools	
Description	**Part Number**
Dwell Meter	91-59339
Magneto Analyzer	91-76032
Remote Starter Switch	91-52024A1
Timing Light	91-99379
Volt/Ohm Meter	91-99750
Timing Jumper	91-818812A1
Liquid Neoprene	92-25711-1

Kent-Moore Tools	
Module Tester	J24642
Kent-Moore Special Tools 29784 Little Mack Roseville, MI 48066 Phone: (313) 574-2332	

Tools/Lubricants Obtained Locally
Point Spring Tension Gauge
Distributor Cam Lubricant

Specifications

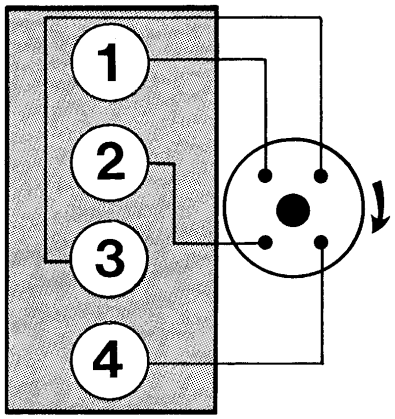
Timing (At Idle RPM)	EST Ignition* 1° BTDC

* Timing must be set using a special procedure as outlined in this section. Timing cannot be properly set using the conventional method.

Spark Plugs

Spark Plug Gap	.035 In. (0.9 mm)
3.0L	AC-MR43T NGK-BR6FS Champion RV15YC4
3.0LX	AC-MR43LTS NGK-BPR6EFS Champion RS12YC

GM 4-Cylinder In-line Firing



Firing Order 1-3-4-2

50683

Description

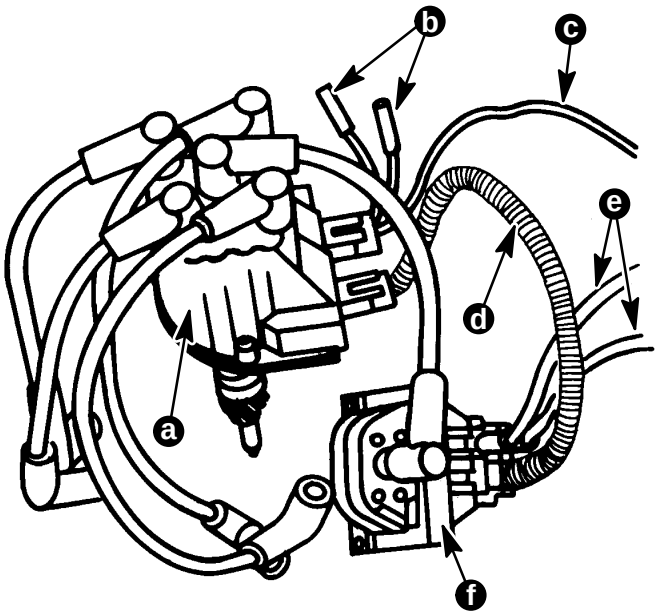
EST or Electronic Spark Timing is a High Energy Ignition System (HEI). The distributor itself has no centrifugal advance mechanism or devices.

The spark plug wires are a carbon-impregnated cord conductor with a silicone rubber jacket. It is important they be handled with care, and routed so as not to cross each other, or to be in contact with other parts of the engine to prevent rubbing.

The EST System uses a square coil with epoxy covered windings to protect against moisture and arc-over.

Index

The timing cannot be set the same way that other ignition systems were.

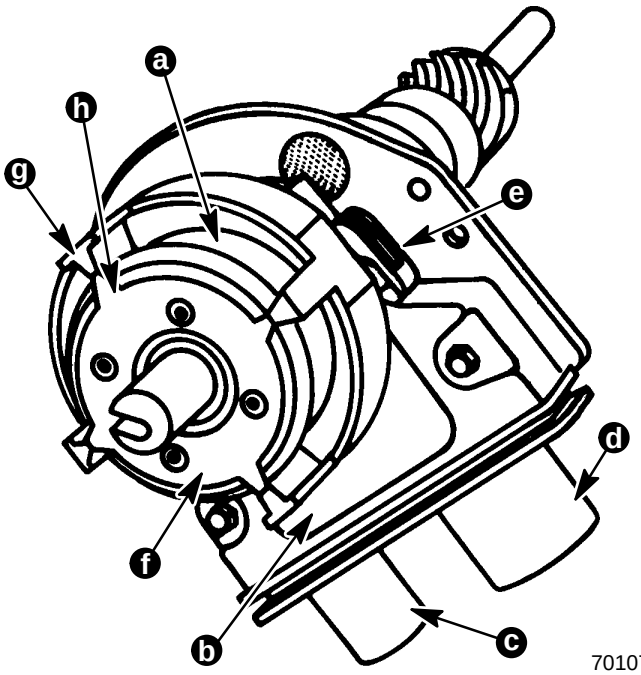


70106

a - Distributor with Spark Plug Wires
b - Wires (WHITE) Used in Timing Procedure
c - Wire from Shift Interrupt Switch
d - Distributor Harness
e - Engine Harness Wire (PURPLE AND GRAY)
f - Coil

EST uses a magnetic pulse generator and an electronic module to primary circuit current. Internally the Pulse Generator, or magnetic pick-up assembly, takes the place of conventional points. A timer core on the main shaft of the distributor has external teeth which align with an equal number of pole piece teeth (four for a four cylinder engine). The electronic module is small enough to allow it to be mounted inside the distributor, and contains the circuits necessary for dwell control and advance of the timing.

Molded into the module is a two-prong connector for the coil terminals and four prong connector. Only three of the four terminals of the second connector are used by MerCruiser (one for the shift interrupt and two white leads are used to “freeze” advance for properly setting initial timing). Inside the distributor, the pick-up coil attaches to the module at a molded prong connector.



70107

a - Magnetic Pulse Generator
b - Electronic Module
c - Two Prong Connector
d - Four Prong Connector
e - Pick-up Coil Connector
f - Timer Core
g - Pole Piece Teeth
h - External Teeth

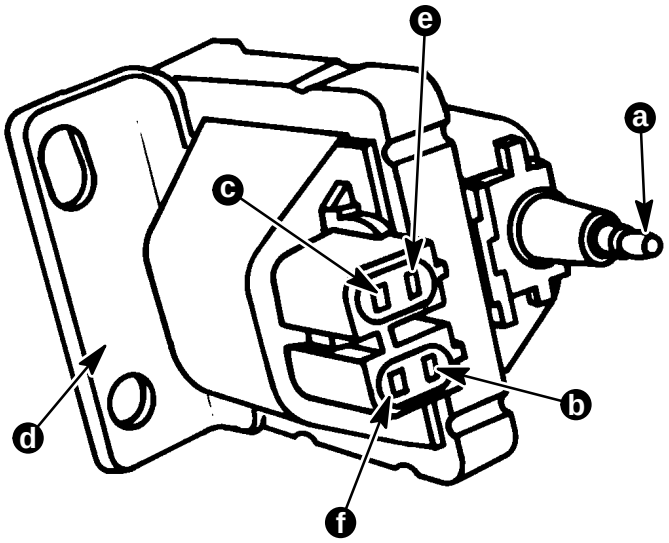
Index

Component Tests

The following tests can be made with the distributor and coil mounted on or off the engine. The test procedures will check each component of the distributor and ignition coil. Distributor cap and rotor should be checked for corrosion, cracks, carbon tracks or wear. Replace if needed.

In order to test the module, an approved module tester, such as Kent-Moore Tester, (J24642 or equivalent), must be used. Be certain to follow the manufacturer's directions precisely for proper results. However, do not overlook that corrosion on the terminals of the module could cause improper ignition action and should therefor be inspected and cleaned if needed.

Testing Ignition Coil



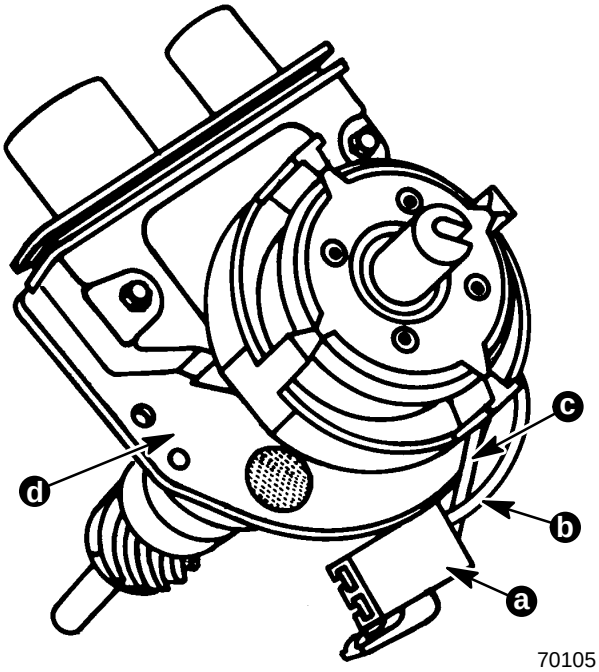
70104

1. If not already done, disconnect wiring from ignition coil. Connectors are molded and keyed to assure proper positioning. The terminal (e) feeds 12 volts to the distributor.

NOTE: *Upon reinstallation, first install black connector (distributor harness) to coil. Then install gray connector (engine harness).*

2. Set ohmmeter to "Rx100" scale and connect one lead to 12 volt terminal (b) of coil and the other lead to "ground" (d), any clean metal on the coil frame. Reading should be infinite. If not, replace coil.
3. Set ohmmeter to "Rx100" scale and connect to 12 volt terminal (b) and terminal (c). Reading should be approximately .4 ohms. If not, replace coil.
4. Set ohmmeter to "Rx1" scale and connect to 12 volt terminal (b) and tachometer terminal (f). Reading should be approximately .4 ohms. If not, replace coil.
5. Set ohmmeter to "Rx100" high scale. Connect ohmmeter to 12 volt terminal (b) and to coil high tension post (a). Reading should be between 7800 and 8800 ohms. If it reads outside of this range, replace coil.

Testing Pickup Coil



70105

a - Connector
b - GREEN Lead
c - WHITE Lead
d - Distributor Housing

1. Remove distributor cap.
2. Identify the two pickup coil leads. On almost all applications these two leads are one WHITE and one GREEN. Remove the connector that houses these two leads from the module.
3. Set ohmmeter to "Rx1" scale. Connect one lead of ohmmeter to WHITE lead and the other to distributor housing. Reading should be infinite. If not, replace pickup coil.
4. Repeat Step 3 with ohmmeter connected to GREEN lead. Reading should be infinite. If not, replace pickup coil.
5. Set ohmmeter to "Rx100" scale. Connect ohmmeter to GREEN and WHITE pickup coil leads. Reading should be constant, unchanging value in the range of 500-1500 ohms. If not, replace pickup coil. Be certain to flex leads by hand during this test to locate possible intermittent "open" circuits (loss of continuity). If any exist, replace pickup coil.

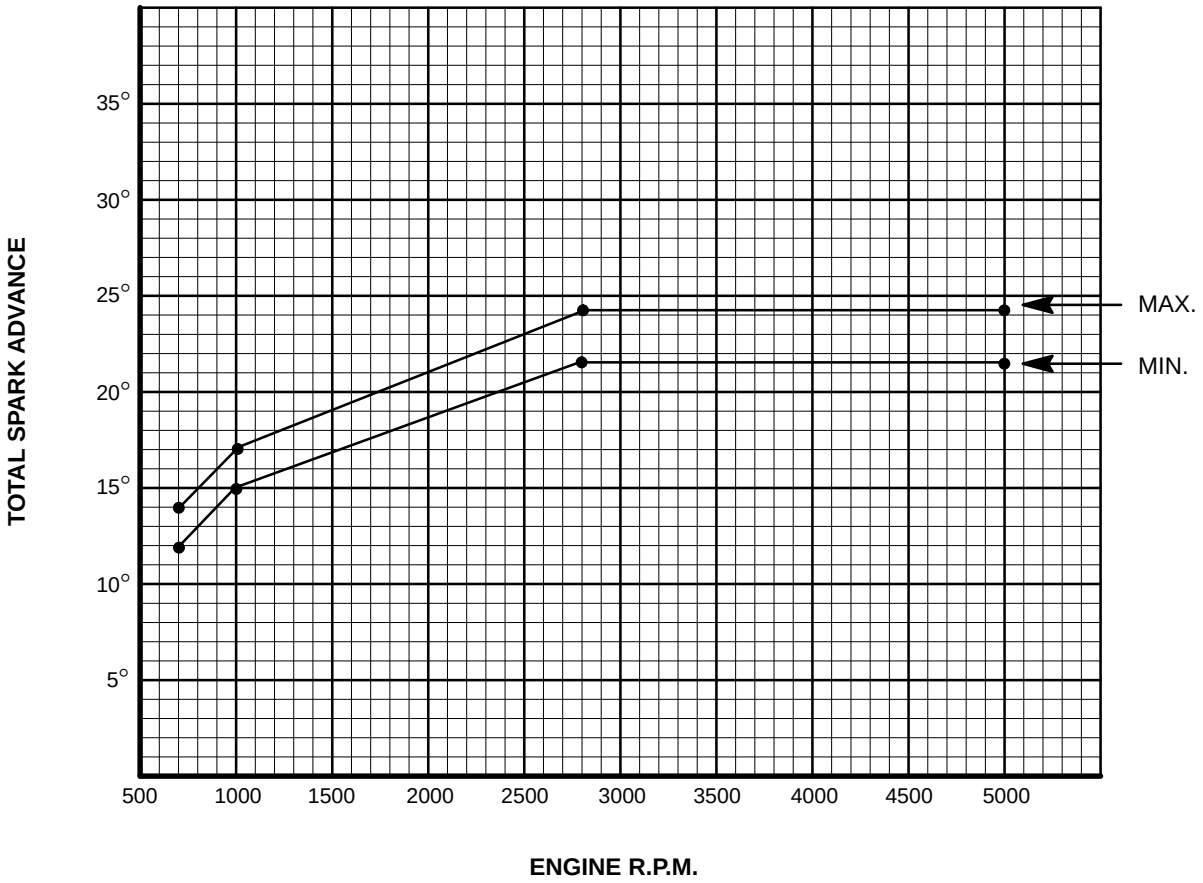
Index

MCM 3.0L, 3.0LX with EST

Module Part Number: 811637
Module Advance: See Notice
Initial Timing: 1° BTDC
Total Advance: 23°

NOTICE

Advance curve includes initial timing. DO NOT add initial timing degrees to total advance degrees.



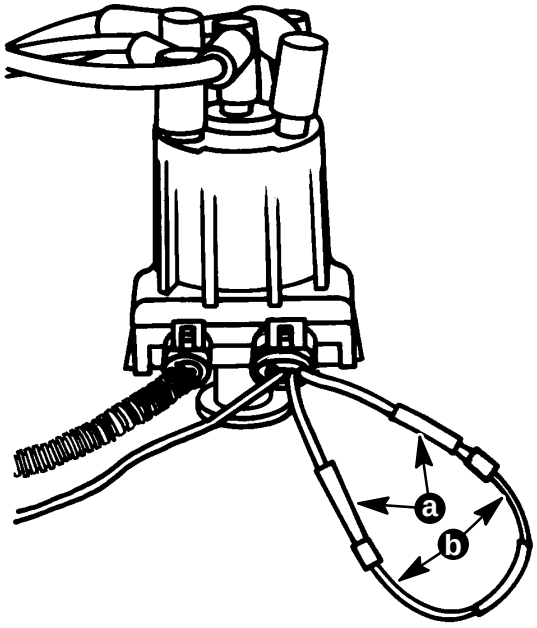
70808-15

Index

Timing Procedure

IMPORTANT: Failure to follow the timing procedure instructions will result in improper timing causing performance problems and possible severe engine damage.

1. Start engine and allow to reach operating temperature.
2. With engine running, install a jumper wire across the two WHITE leads on the distributor using (91-818812A1), or fabricate one using a 6 in. (150 mm) section of 16 gauge wire with two male bullet terminal ends connected.



70103

a - WHITE Leads
b - Jumper Lead

3. Bypass the shift interrupt switch by disconnecting wires at shift interrupt switch. Temporarily join the engine harness wires together.

IMPORTANT: Do not fail to reconnect these two wires to the shift interrupt switch when timing procedures are complete.

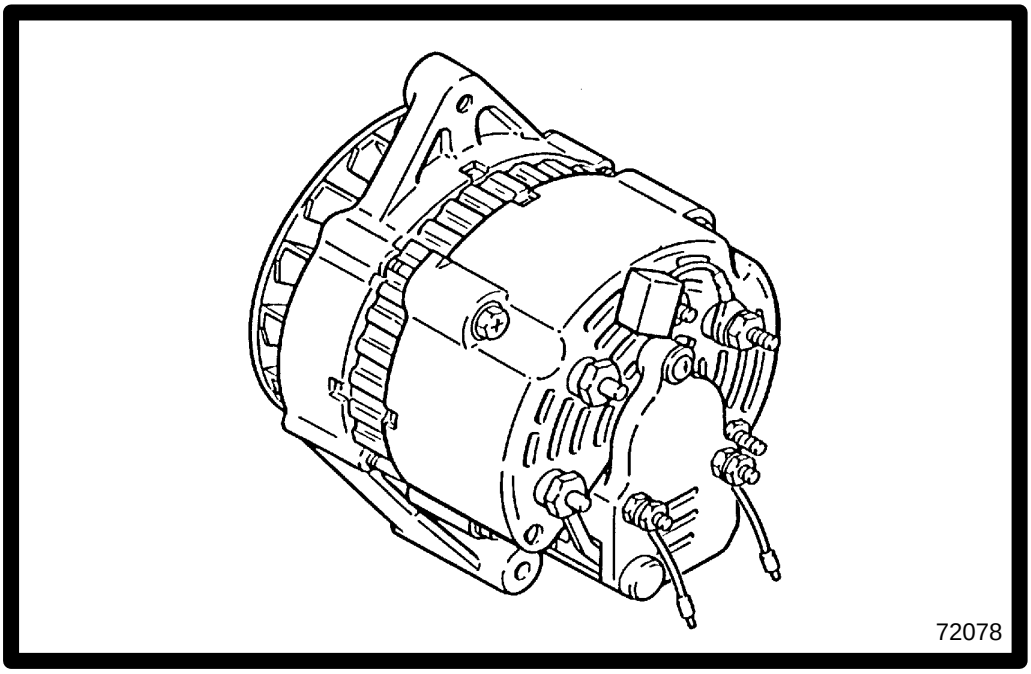
4. With timing light connected, check timing. Timing should be 1° BTDC.
5. If required, loosen distributor hold down clamp and rotate distributor to obtain specified timing.
6. Secure distributor hold down clamp, and recheck timing as above.
7. Reconnect the two wires to the shift interrupt switch. Remove jumper wire at distributor white leads.

IMPORTANT: Be sure to remove jumper wire before returning engine to service, otherwise timing will not advance.

8. With timing light still connected, and engine at IDLE, verify that timing did advance to 12° BTDC, (plus or minus 2°). At 2400-2800 RPM maximum (total) advance is obtained and should be 27° BTDC (plus or minus 2°).

Index

ELECTRICAL SYSTEMS



4

C

CHARGING SYSTEM

Index

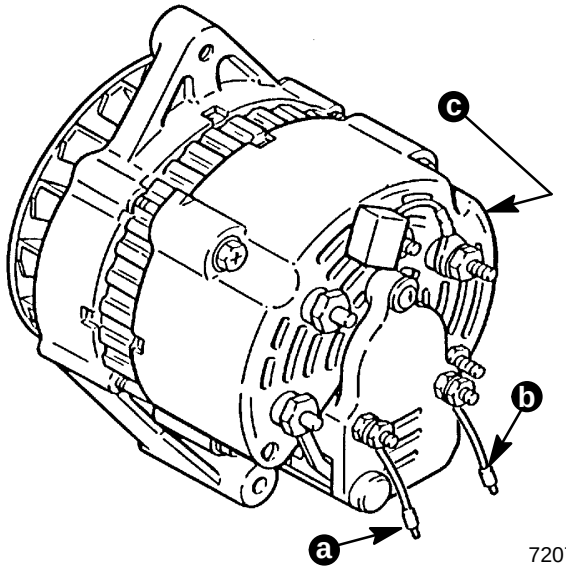
Table of Contents

	Page
Identification	4C - 1
Replacement Parts Warning	4C - 1
Mando 55 Amp Alternator	4C - 1
Specifications	4C - 1
Tools/Sealants	4C - 1
Torque Specifications	4C - 2
Description	4C - 2
Precautions	4C - 3
System Components	4C - 3
Periodic Maintenance	4C - 4
Drive Belt Tension Adjustment	4C - 4
Alternator	4C - 4
Troubleshooting Tests (Alternator on Engine)	4C - 5
Circuitry Test	4C - 5
Output Circuit	4C - 5
Excitation Circuit	4C - 5
Sensing Circuit	4C - 6
Current Output Test	4C - 6
Voltage Output Test	4C - 7
Alternator Repair	4C - 8
Removal	4C - 8
Exploded View	4C - 9
Disassembly	4C - 10
Cleaning and Inspection	4C - 12
Component Testing	4C - 13
Rotor	4C - 13
Stator	4C - 14
Rectifier and Diode Assembly	4C - 15
Condenser	4C - 16
Reassembly	4C - 16
Installation	4C - 19
Prestolite 55 Amp Alternator	4C - 19
Replacement Parts Warning	4C - 19
Specifications	4C - 19
Tools/Sealants	4C - 19
Torque Specifications	4C - 20
Description	4C - 20
Precautions	4C - 20

	Page
Exploded View	4C - 21
System Components	4C - 22
Periodic Maintenance	4C - 22
Drive Belt Tension Adjustment	4C - 23
Alternator	4C - 23
Troubleshooting Tests (Alternator on Engine)	4C - 23
Circuitry Test	4C - 23
Alternator Output Test	4C - 23
Harness Voltage Test	4C - 24
Open Diode-Trio Test	4C - 24
Current Output Test	4C - 25
Open Regulator test	4C - 26
Alternator Repair	4C - 27
Removal	4C - 27
Disassembly	4C - 27
Cleaning and Inspection	4C - 29
Front Bearing	4C - 29
Removal	4C - 29
Installation	4C - 29
Slip Rings/Rear Bearing	4C - 30
Removal	4C - 30
Installation	4C - 30
Component Testing	4C - 31
Rotor	4C - 31
Stator	4C - 32
Positive/Negative Rectifier and Diode-Trio Assembly	4C - 33
Identification	4C - 33
Negative (–) Rectifier	4C - 33
Positive (+) Rectifier and Diode-Trio	4C - 33
Condenser	4C - 34
Reassembly	4C - 34
Installation	4C - 36
Battery Isolators	4C - 37
Dual Battery Charging Systems Using a Battery Isolator	4C - 37
Battery Isolator Diagram	4C - 38

Index

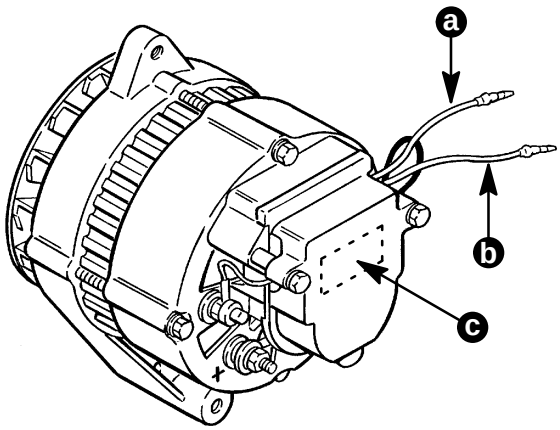
Identification



72078

a - Excitation Wire - PURPLE
b - Sensing Wire - RED/PURPLE
c - Mando Part Number (Hidden in This View)

Mando 55 Amp Alternator



73078

a - Excitation Wire - PURPLE
b - Sensing Wire - RED/PURPLE
c - Prestolite Part Number

Prestolite 55 Amp Alternator

Replacement Parts Warning

⚠ WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Mando 55 Amp Alternator

Specifications

Description	Specification
Excitation Circuit	1.3-2.5 Volts
Current Output	50 Amp Minimum
Voltage Output	13.9-14.7 Volts
Condenser Capacity	.5 MFD
Minimum Brush Length	1/4 In. (6mm)

Tools/Sealants

Description	Part Number
Bearing Removal and Installation Kit	91-31229A5
Magneto Analyzer	91-76032
Universal Puller Plate	91-37241
Multi-Meter/DVA Tester	91-99750
Quicksilver Liquid Neoprene	92-27511--1
Ammeter (0-50 Amps)	Obtain Locally

Index

Torque Specifications

Fastener Location	Lb In.	Lb. Ft.	N·m
End Frame Screws	55		6.5
Brush Setscrews	18		1.5
Regulator Mounting Screws	43		4.5
Regulator Leads	25		2.5
Ground Terminal Nut	25		2.5
Pulley Nut		42	58
Alternator Brace to Alternator	192		28
Alternator Brace to Block		30	40
Alternator to Mounting Bracket	35		48
Alternator Mounting Bracket	30		41
V-Belt Tension (Note)	Depress 1/2 In. (13mm)		

NOTE: Depress belt with thumb at midway point between circulating pump pulley and alternator.

Description

The alternator has a rotor, which is supported in two end frames by ball bearings, and is driven by a pulley at approximately twice engine speed. The rotor contains a field winding that is enclosed between two multiple-finger pole pieces. The ends of the field winding are connected to two brushes (mounted in the rear end frame) which make continuous sliding (or slipping) contact with the slip rings. The current (flowing through the field winding) creates a magnetic field that causes the adjacent fingers of the pole pieces to become alternate north and south magnetic poles.

A 3-phase stator is mounted directly over the rotor pole pieces and between two end frames. It consists of three windings wound 120 degrees electrically out-of-phase on the inside of a laminated core. The windings are all connected together on one end, while the other ends are connected to a full-wave rectifier bridge.

The rectifier bridge contains six diodes which are arranged so that current flows from ground, through the stator and to the output terminal, but not in the opposite direction.

When current is supplied to the rotor field winding, and the rotor is turned, the movement of the magnetic fields created induces an alternating current into the stator windings. The rectifier bridge then changes this alternating current to direct current which appears at the output terminal. A diode trio also is connected to the stator windings to supply current to the regulator and the rotor field during operation.

Voltage output of the alternator is controlled by regulating the current supplied to the rotor field. This is accomplished by a transistorized voltage regulator that senses the voltage at the battery and regulates the field current to maintain alternator voltage within prescribed limits for properly charging the battery. Current output of the alternator does not require regulation, as maximum current output is self-limited by the design of the alternator. As long as the voltage is regulated within the prescribed limits, the alternator cannot produce excessive current. A cut-out relay in the voltage regulator also is not required, as the rectifier diodes (which allow current to flow in one direction only) prevent the battery from discharging back through the stator.

Due to the lack of residual magnetism in the rotor pole pieces, a small amount of current must be supplied to the rotor field to initially start the alternator charging. This is accomplished by means of an excitation circuit in the regulator which is connected to the ignition switch. Once the alternator begins to produce output, field current is supplied solely by the diode trio, as explained, preceding.

The alternator also is equipped with a fan (mounted on the rotor shaft) which induces air flow through the alternator to remove the heat created by the rectifiers and stator. A capacitor protects the rectifier system from high voltages and suppresses radio noise.

Index

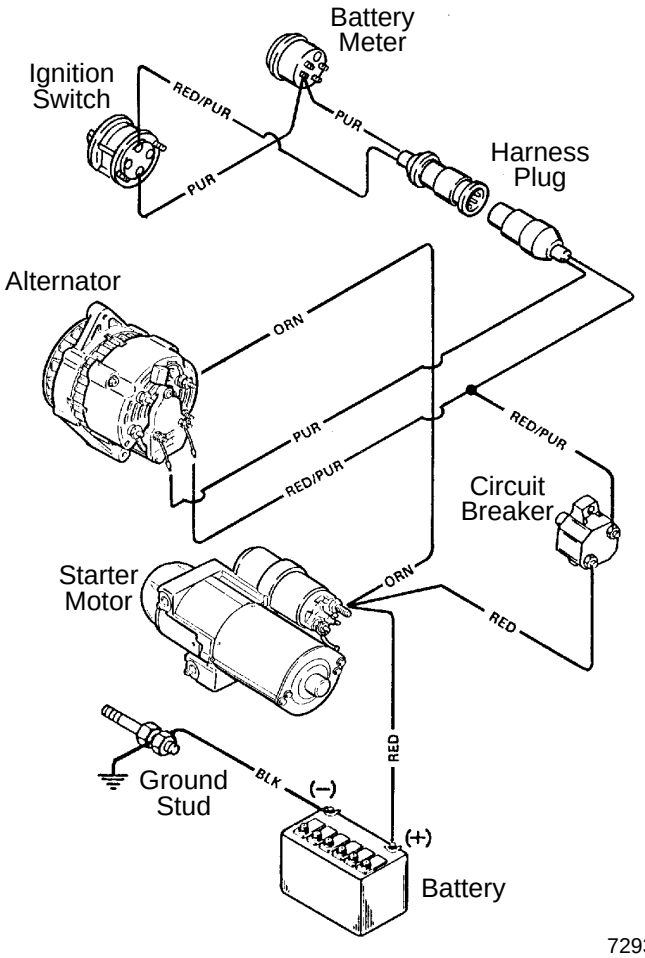
Precautions

The following precautions MUST BE observed when working on the alternator system. Failure to observe these precautions may result in serious damage to the alternator or alternator system.

1. DO NOT attempt to polarize the alternator.
2. DO NOT short across or ground any of the terminals on the alternator, except as specifically instructed in the “Troubleshooting Tests.”
3. NEVER disconnect the alternator output lead or battery cables when the alternator is being driven by the engine.
4. NEVER disconnect regulator lead from alternator regulator terminal when the alternator is being driven by the engine.
5. ALWAYS remove negative (–) battery cable from battery before working on alternator system.
6. When installing battery, BE SURE to connect the positive (+) battery cable to the positive (+) battery terminal and the negative (–) (grounded) battery cable to negative (–) battery terminal.
7. If a charger or booster battery is to be used, BE SURE to connect it in parallel with existing battery (positive to positive; negative to negative).

System Components

The alternator system consists of the alternator, battery, the ignition switch and the wiring which connects these components.



72933

Index

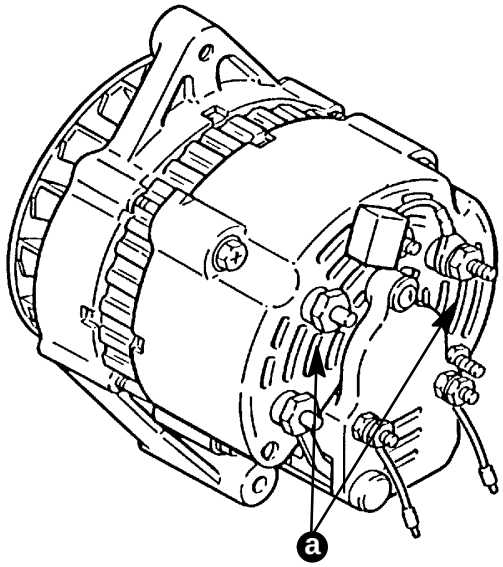
Periodic Maintenance

The following maintenance check should be performed every 50 hours or 60 days (whichever comes first) in fresh water areas or every 25 hours or 30 days in salt water areas.

⚠CAUTION

Remove all battery cables from battery (before conducting the following check) to prevent accidentally shorting out electrical system.

1. Inspect entire alternator system for corroded or loose connectors.
2. Check wiring for frayed or worn insulation.
3. Check alternator drive belt for excessive wear, cracks, fraying and glazed surfaces. Also, check drive belt tension and adjust, if necessary, as explained under “Drive Belt Tension Adjustment.”
4. Check alternator mounting bolts for adequate tightness.
5. Inspect slip ring end frame flame arrestor screen for debris and clean, if necessary, using compressed air or a cloth. Screen MUST BE clean, or alternator may overheat.



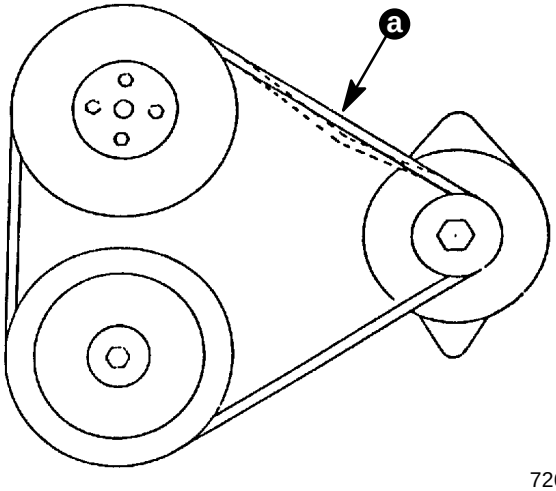
72078

a - Inspect This Area

Drive Belt Tension Adjustment

Alternator

1. Install drive belt on pulleys and adjust tension as follows:
   a. Pivot alternator away from engine, as required, until correct tension is obtained as shown. Belt should depress 1/2 in. (13 mm).



72669

a - Check Point

   b. After obtaining correct tension, securely retighten alternator brace attaching bolts and alternator mounting bolts.
2. If a new drive belt has been installed, recheck belt tension after running for five minutes.

Index

Troubleshooting Tests (Alternator on Engine)

Use the following tests in conjunction with the “Troubleshooting” in Section 1. Before proceeding with the tests, however, perform the following checks to eliminate possible problem areas. Also observe “Precautions,” preceding, to prevent damage to alternator system.

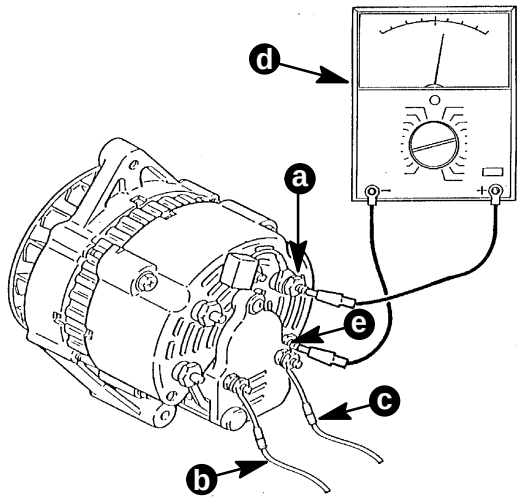
1. If problem is an undercharged battery, check to ensure that undercharged condition has not been caused by excessive accessory current draw or by accessories which have accidentally been left on. Also, check that undercharged condition has not been caused by running engine at too low a speed for extended periods of time.
2. Check physical condition and state of charge of battery, as outlined in “Battery - Storage” in Section 4A. Battery MUST BE at least 75% (1.230 specific gravity) of fully charged to obtain valid results in the following tests. If not, charge battery before testing system.
3. Inspect entire alternator system wiring for defects. Check all connections for tightness and cleanliness, particularly battery cable clamps and battery terminals.
4. Check alternator drive belt for excessive wear, cracks, fraying and glazed surfaces and replace if necessary. Also, check drive belt tension and adjust if necessary, as outlined under “Drive Belt Tension Adjustment.”

Circuitry Test

Perform the following tests, using a 0-20 volt DC voltmeter, to check that all of the circuits between the alternator and the other components within the alternator system are in good condition.

OUTPUT CIRCUIT

1. Connect positive (+) voltmeter lead to alternator output terminal and negative (–) lead to a ground terminal on alternator.
2. Wiggle engine wiring harness while observing voltmeter. Meter should indicate approximate battery voltage and should not vary. If no reading is obtained, or if reading varies, check alternator output circuit for loose or dirty connections or damaged wiring.



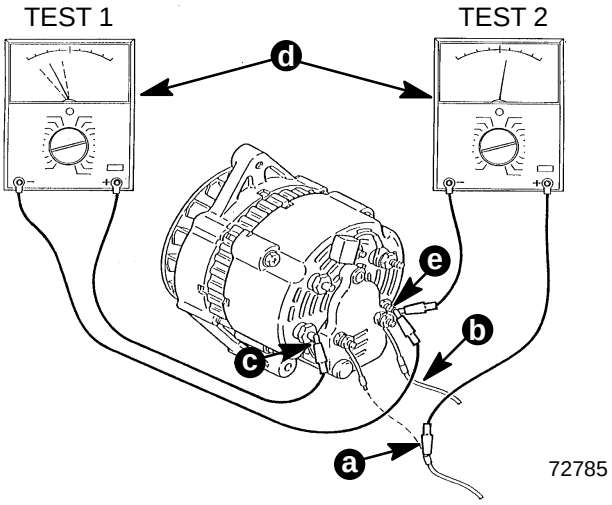
72784

a - Output Wire - ORANGE
b - Excitation Wire - PURPLE
c - Sensing Wire - RED/PURPLE
d - Voltmeter (0-20 Volts)
e - Ground

EXCITATION CIRCUIT

1. Connect positive (+) voltmeter lead to tie strap terminal on alternator and negative (–) lead to a ground terminal on alternator (Test 1).
2. Turn ignition switch to ON position and note voltmeter reading. Reading should be 1.3 to 2.5 volts.
3. If no reading is obtained, an opening exists in alternator excitation lead or in excitation circuit of regulator. Unplug PURPLE lead from regulator. Connect positive voltmeter lead to PURPLE lead and negative voltmeter leads to ground (Test 2). If voltmeter now indicates approximate battery voltage, voltage regulator is defective and must be replaced. If no voltage is indicated, check excitation circuit for loose or dirty connections or damaged wiring.

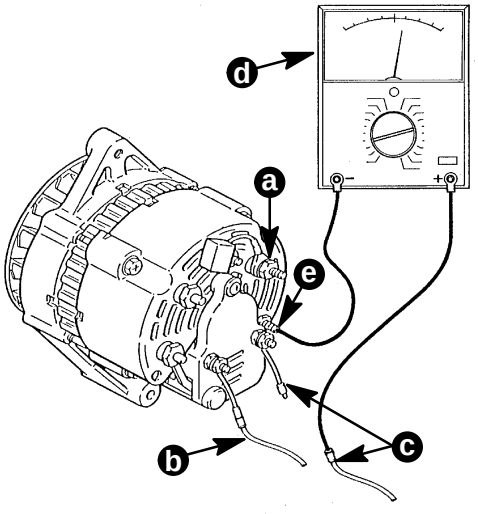
4. If reading is between .75 and 1.1 volts, rotor field circuit probably is shorted or grounded. Disassemble alternator and test rotor as outlined under “Alternator Repair,” following.
5. If reading is between 6.0 and 7.0 volts, rotor field circuit probably is open. Remove regulator and inspect for worn brushes or dirty slip rings. Replace brushes if less than 1/4 in. (6 mm) long. If brushes and slip rings are in good condition, disassemble and perform rotor test as outlined under “Component Testing - Rotor” following.



a - Excitation Wire - PURPLE
b - Sensing Wire - RED/PURPLE
c - Tie Bar
d - Voltmeter (0-20 Volts)
e - Ground

SENSING CIRCUIT

1. Unplug RED/PURPLE lead from voltage regulator.
2. Connect positive (+) voltmeter lead to RED/PURPLE lead and negative (–) voltmeter lead to ground terminal.
3. Voltmeter should indicate battery voltage. If battery voltage is not present, check sensing circuit RED/PURPLE lead for loose or dirty connection or damaged wiring.



a - Output Wire - ORANGE
b - Excitation Wire - PURPLE
c - Sensing Wire - RED/PURPLE
d - Voltmeter (0-20 Volts)
e - Ground

Current Output Test

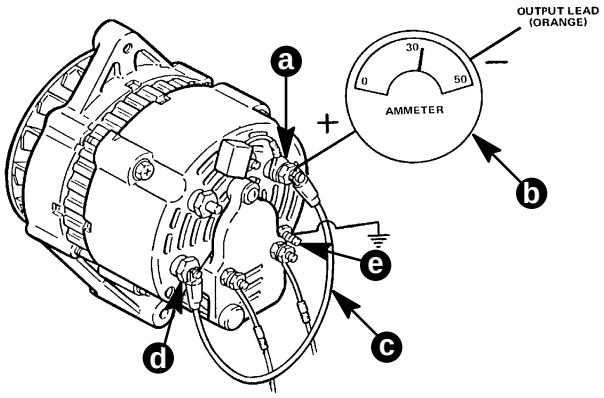
Perform this test to check if alternator is capable of producing rated current output, using a 0-50 amp DC ammeter.

⚠ WARNING

Be sure that engine compartment is well-ventilated and that there are no gasoline vapors present (during the test) to prevent the possibility of an explosion and/or a fire, should a spark occur.

1. Disconnect negative (–) battery cable from battery.
2. Disconnect ORANGE lead from alternator output terminal and connect ammeter in series between lead and output terminal. Connect positive (+) side of ammeter toward output terminal.
3. Reconnect negative battery cable.
4. Remove coil wire from distributor cap tower and ground it to block. Turn on all accessories and crank engine over with starter motor for 15-20 seconds.

5. Turn off accessories and reinstall coil wire. Start engine and adjust engine speed to 1500-2000 RPM. Quickly observe ammeter. Reading should be at least 30 amps.
6. If reading is low, stop engine and connect a jumper wire between alternator output terminal and regulator terminal. Repeat Steps 4 and 5.
7. If reading is now within specifications, diodes are faulty. Disassemble alternator and replace rectifier as explained under “Alternator Repair,” following, to determine if fault is in regulator or alternator.
8. If reading is still low with jumper wire connected, perform “Voltage Output Test,” following, to determine if fault is in regulator or alternator.



72787

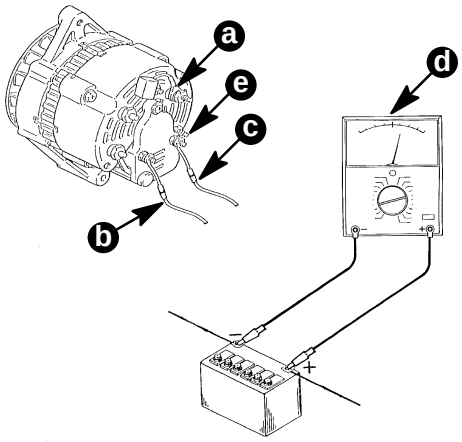
a - Output Wire - ORANGE
b - Ammeter (0-50 Amps)
c - Jumper Lead
d - Regulator Terminal
e - Ground

Voltage Output Test

Perform this test to determine if voltage regulator is operating correctly, using a 0-20 volt DC voltmeter.

IMPORTANT: Battery MUST BE fully charged (1.260 or above specific gravity) to obtain proper voltage reading in this test. If necessary, charge battery with a battery charger or allow engine to run a sufficient length of time to fully charge battery before taking reading.

1. Connect positive (+) voltmeter lead to positive (RED) battery terminal and negative (–) voltmeter lead to negative (BLACK) terminal.
2. Start engine and run at fast idle until engine reaches normal operating temperature. Adjust engine speed to 1500-2000 RPM and observe voltmeter for highest reading. Reading should be between 13.9 and 14.7 volts.
3. If reading is high, check for a loose or dirty regulator ground lead connection. If connection is good (and sensing circuit checked out good in “Circuitry Test”), voltage regulator is faulty and must be replaced. Be sure to disconnect battery cables before attempting to remove regulator.



72788

a - Output Wire - ORANGE
b - Excitation Wire - PURPLE
c - Sensing Wire - RED/PURPLE
d - Voltmeter (0-20 Volts)
e - Ground

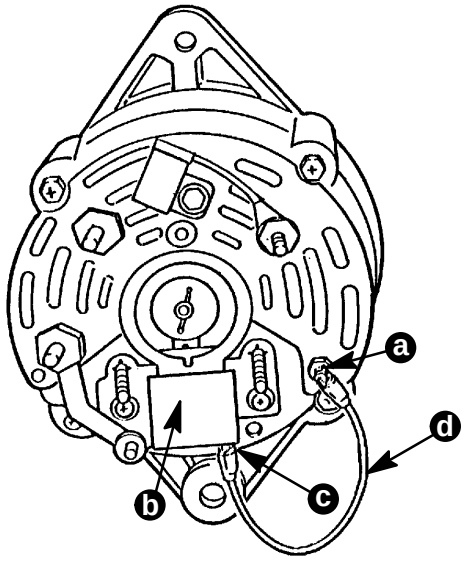
⚠WARNING

Be sure that engine compartment is well-ventilated and that there are no gasoline vapors present (during the next steps) to prevent the possibility of an explosion and/or fire, should a spark occur.

⚠CAUTION

DO NOT allow tie jumper wire to contact alternator end frame (in next step), as rectifier and diode assembly may be damaged.

4. Remove four nuts holding excitation and sensing wires and Phillips screw. Remove regulator cover and install wires and nuts for testing. Connect a jumper wire from the ground stud to the brush terminal on the lower right- hand side of the brush assembly. Restart engine and gradually increase engine speed to 1500 RPM while observing voltmeter. DO NOT allow voltage to exceed 16 volts.
5. If a voltmeter reading of 14.5 volts or above is now obtained, voltage regulator is faulty and must be replaced. If voltmeter reading is below 14.5 volts, inspect brushes and slip rings for wear, dirt or damage. If brushes and slip rings are good, alternator is faulty internally. Disassemble alternator and test components, as outlined under “Alternator Repair,” following.



72971

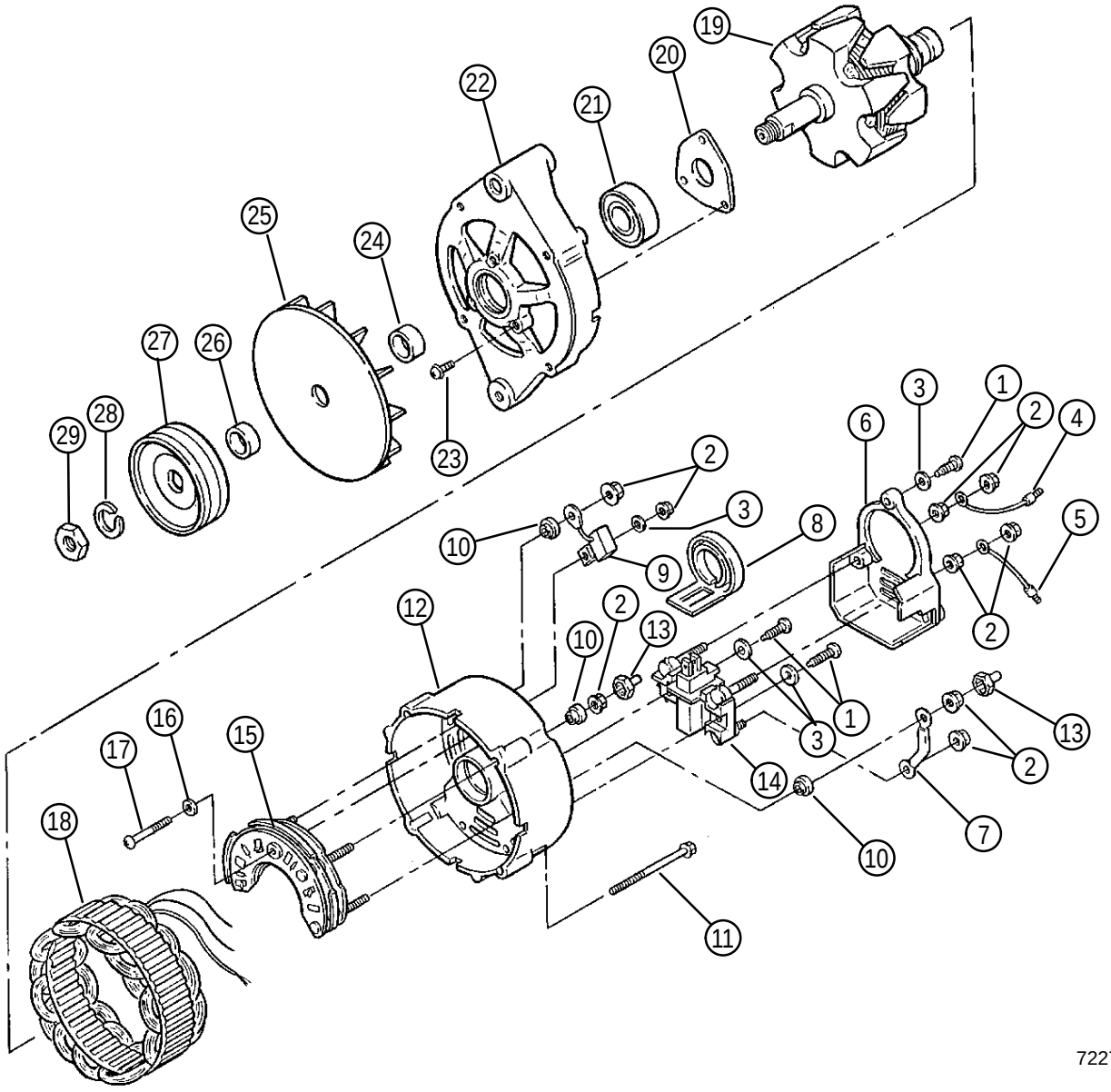
a - Ground
b - Brush/Regulator Assembly
c - Brush Terminal
d - Jumper Wire (Solder Connection to Ground)

Alternator Repair

Removal

1. Disconnect negative (–) battery cable from battery.
2. Disconnect wiring harness from alternator.
3. Remove alternator brace-to-alternator attaching bolt, washer(s) and spacer (if used).
4. Loosen alternator brace-to-engine attaching bolt and alternator mounting bolt, then pivot alternator inward and remove alternator drive belt.
5. Remove alternator mounting bolt, washers (if used), spacer and nut, and remove alternator.

Exploded View



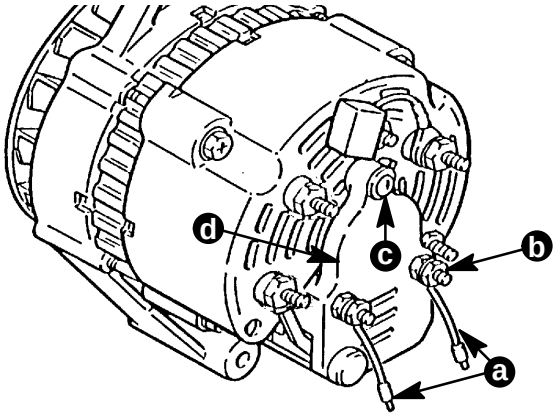
1 - Screw (3)
2 - Nut (9)
3 - Flat Washer (4)
4 - Sensing Wire (RED/PURPLE)
5 - Excitation Wire (PURPLE)
6 - Cover
7 - Tie Strap
8 - Rubber Gasket
9 - Condenser
10 - Insulator (3)
11- Bolt (4)
12 - End Frame (Rear)
13 - Cap (2)
14 - Brush / Regulator Assembly
15 - Rectifier Assembly
16 - Flat Washer
17 - Screw
18 - Stator
19 - Rotor and Slip Rings
20 - Retaining Plate
21 - Front Bearing
22 - End Frame (Front)
23 - Screw (3)
24 - Fan Spacer
25 - Fan
26 - Pulley Spacer
27 - Pulley
28 - Lockwasher
29 - Nut

Index

Disassembly

IMPORTANT: The following instructions are for complete disassembly and overhaul of the alternator. In many cases, however, complete disassembly of alternator is not required and, in those cases, it is necessary only to perform the operations required to repair or replace the faulty part.

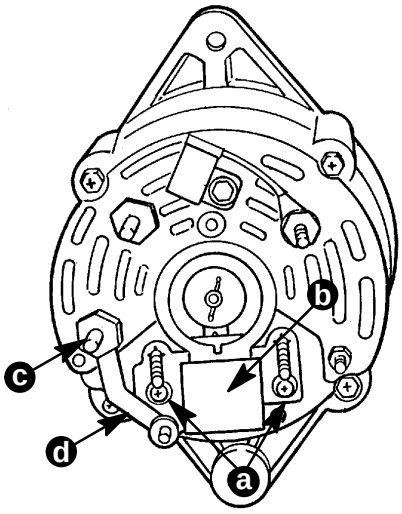
1. Mount alternator in a vise so that rear end frame is facing you.
2. Disconnect regulator leads from terminals on rear end frame. Remove four nuts, Phillips head screw and two regulator leads. Then pull regulator cover away from rear end frame.



72963

a - Regulator Leads
b - Nuts (4)
c - Phillips Head Screw
d - Regulator Cover

3. Remove stud cover insulator, two nuts and tie strap from brush/regulator assembly.
4. Remove two brush/regulator attaching screws and remove brush/regulator assembly.



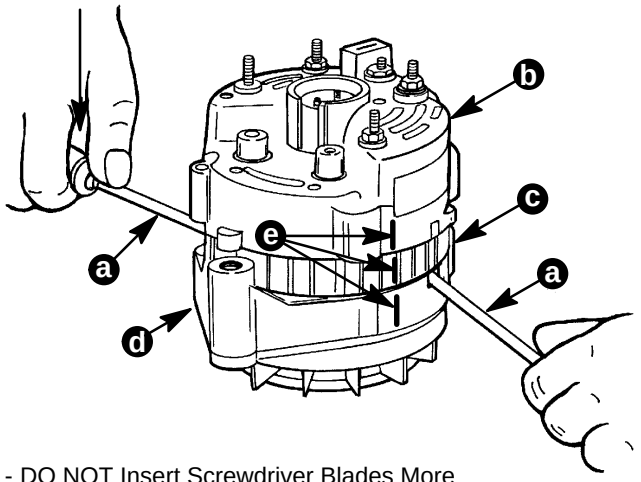
72823

a - Screws
b - Brush/Regulator Assembly
c - Stud Cover Insulator
d - Tie Strap

5. Scribe a mark on rear end frame, stator and front end frame to ensure proper reassembly later.
6. Remove four screws which secure end frames and stator together.

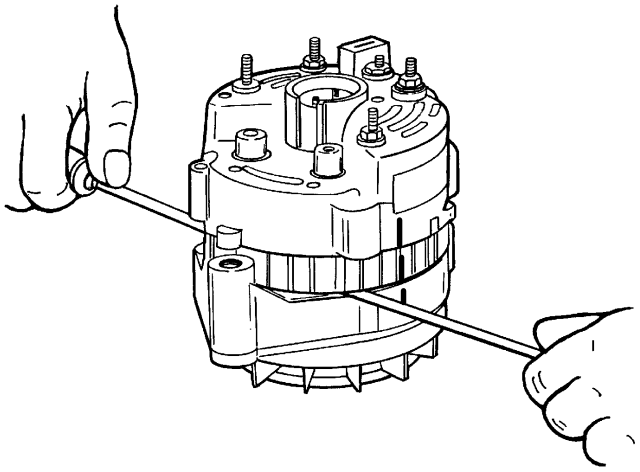
IMPORTANT: DO NOT insert screwdriver blades more than 1/16 in. (1.5 mm) into openings (in next step), as stator windings may be damaged.

7. Separate rear end frame and stator assembly from front end frame and rotor assembly using two thin blade screwdrivers (positioned 180 degrees apart from one another) at the locations shown. Use the two slots shown to initially separate units.



72824

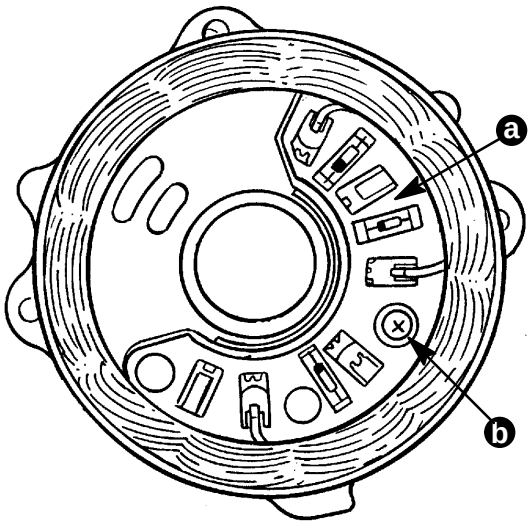
a - DO NOT Insert Screwdriver Blades More Than 1/16 In. (1.5 mm) into Slots
b - Rear End Frame
c - Stator
d - Front End Frame
e - Scribe Marks



72825

8. Place rear end frame and stator assembly on the bench with stator downward. Be sure that bench is clean and free of metal chips. Remove nuts, washers, insulators and condenser from output and ground studs.

9. Turn end frame over (stator upward) and remove one Phillips head screw which secures rectifiers to end frame.

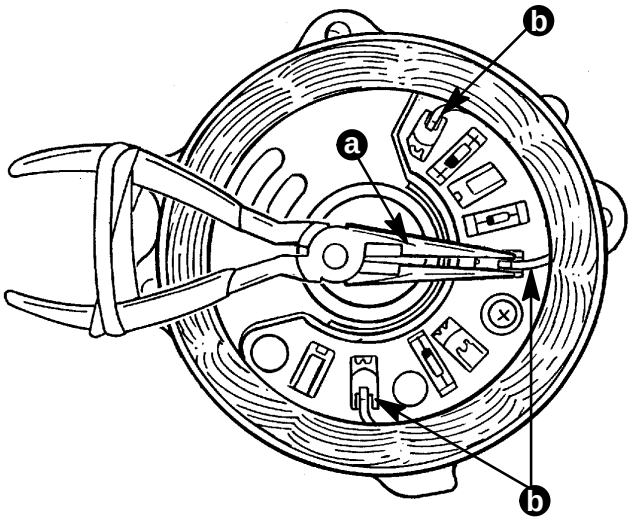


72826

a - Rectifier Assembly
b - Phillips Head Screw

10. Separate stator and rectifier assembly from rear end frame using screwdriver slots.

11. Unsolder the three stator leads from the rectifier heat sink. Place a needle nose pliers on diode terminal between solder joint and diode body to help prevent heat damage to diodes. Unsolder joints as quickly as possible and allow diode terminal to cool before removing pliers.



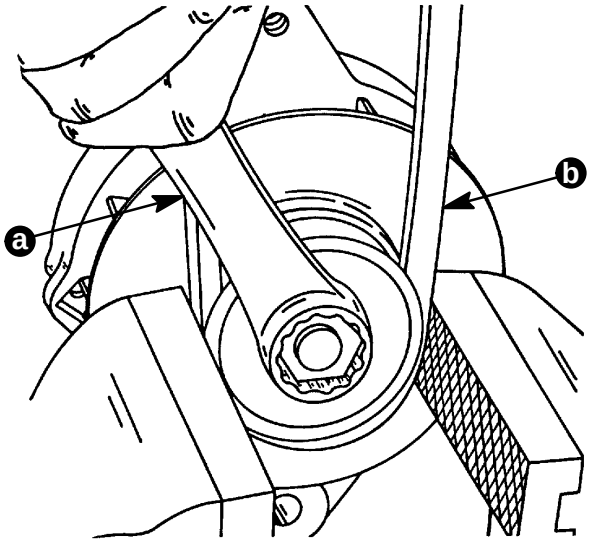
72827

a - Heat Sink
b - Stator Leads (3)

IMPORTANT: With alternator disassembled to this point, stator, rectifier, diodes, and rotor may be tested, as explained under "Component Testing," following.

IMPORTANT: DO NOT clamp vise on rotor pole pieces when removing pulley nut (in next step), as pole pieces may be distorted.

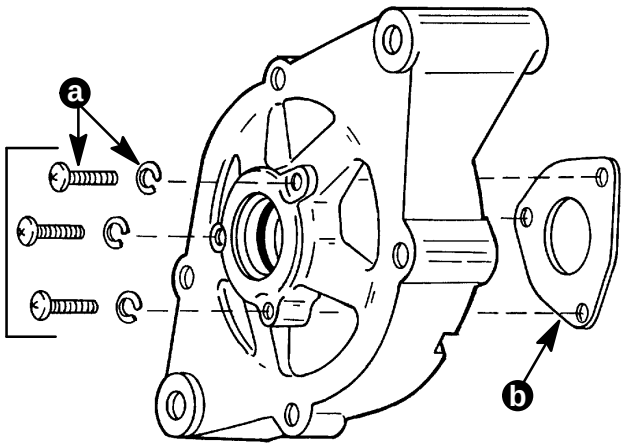
12. Remove pulley retaining nut by clamping pulley in a vise (using an oversize V-belt or protective jaws to protect pulley) and turning nut counterclockwise with a 7/8 in. wrench. Remove lockwasher and slide pulley and fan from shaft. If pulley is difficult to remove, it may be necessary to use a universal puller.



72828

a - 7/8 In. Wrench
b - Over-Sized V-Belt to Protect Pulley

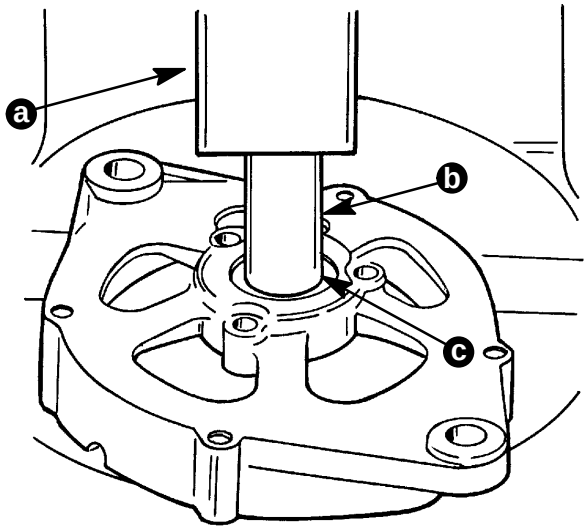
13. Remove the three Phillips head screws and lockwashers which secure the front bearing retaining plate.



72829

a - Phillips Head Screws and Lockwashers
b - Front Bearing Retaining Plate

14. Remove front bearing from front end frame using an arbor press and a suitable size mandrel. (Discard bearing.)



72830

a - Press
b - Mandrel
c - Bearing

15. If rotor slip rings or rear bearing requires replacement, entire rotor must be replaced. Parts cannot be purchased separately.

Cleaning and Inspection

1. Clean all parts with a clean, soft cloth. DO NOT use solvent, or electrical components may be damaged.
2. Inspect the following parts for wear and damage:
   a. **Brush/regulator assembly** - inspect for cracked casing, damaged brush leads, poor brush lead solder connections, weak or broken brush springs or worn brushes. Replace brush set if brushes are less than 1/4 in. (6 mm) long.
   b. **Rotor** - inspect for stripped threads, scuffed pole piece fingers or damaged bearing surfaces (because of bearing turning on shaft).
   c. **Rotor-slip rings** - clean slip rings with 400 grain (or finer) polishing cloth while spinning rotor in a lathe. Blow off dust with compressed air. Inspect slip rings for grooves, pits, flat spots or out-of-round [.002 in. (0.051 mm) maximum] and replace rotor, if present.

Index

d. **Rotor shaft and front end bearings** - inspect for damaged seals, lack of lubrication, discoloration (from overheating) and excessive side or end play. Bearing should turn freely without binding or evidence of rough spots.

e. **Stator** - inspect for damaged insulation or wires; also inspect insulating enamel for heat discoloration, as this is usually a sign of a shorted or grounded winding or a shorted diode.

f. **Front and rear end frames** - inspect for cracks, distortion, stripped threads or wear in bearing bore (from bearing outer race spinning in bore). End frame(s) MUST BE replaced, if bearing has spun. Also, inspect bearing retainer recess in front end frame for damage.

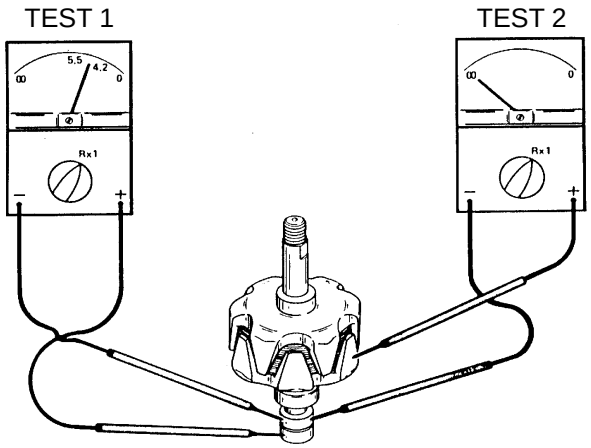
g. **Fan** - inspect for cracked or bent fins, broken welds (bi-rotational fan only) or worn mounting hole (from fan spinning on shaft).

h. **Pulley** - inspect pulley mounting bore end for wear. Inspect drive surface of pulley sheaves for trueness, excessive wear, grooves, pits, nicks and corrosion. Repair damaged surfaces, if possible, with a fine file and a wire brush or replace pulley, if beyond repair. Drive surfaces MUST BE perfectly true and smooth or drive belt wear will be greatly accelerated.

Component Testing

ROTOR

1. Test rotor field circuit for opens, shorts or high resistance (Test 1), using an ohmmeter (set on R x1 scale), as follows:



72831

Testing Rotor Field Circuit

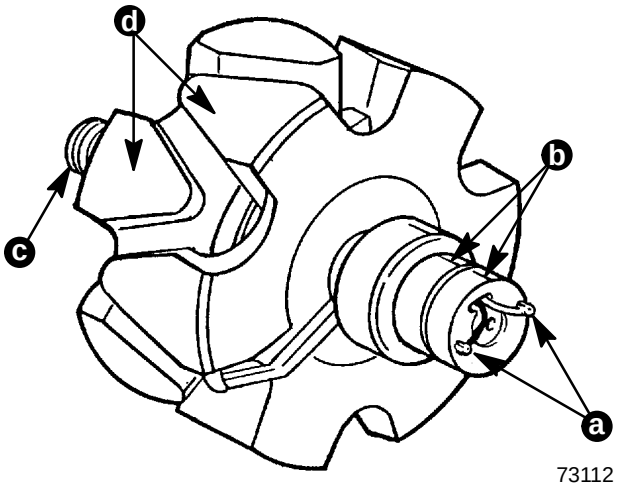
Testing Rotor Field

a. Connect one ohmmeter lead to each slip ring.

b. Ohmmeter reading should be 4.2 to 5.5 ohms with rotor at room temperature 70-80°F (21-26°C).

c. If reading is high or infinite (no meter movement), high resistance or an open exists in the field circuit. Check for poor connections between field winding leads and slip ring terminals. If cause for open or high resistance cannot be found, connect ohmmeter directly to slip ring terminals. If correct reading is now obtained, or if reading is still high or infinite, replace complete rotor assembly.

d. If reading is low, a short exists in the field circuit. Inspect slip rings to be sure that they are not bent and touching outer slip ring. Also, be sure that excess solder is not shorting terminals to aft slip ring. If cause for short cannot be found, unsolder field winding leads from slip ring terminals and connect ohmmeter directly to leads. If correct reading is now obtained, or if reading is still low, slip rings and rotor field windings are shorted, and complete rotor assembly must be replaced.



73112

a - Field Winding Leads
b - Slip Rings
c - Rotor Shaft
d - Pole Pieces

2. Test rotor field circuit for grounds (Test 2), using an ohmmeter (set on R x1 scale) as follows:

   a. Connect one lead of ohmmeter to either slip ring and the other lead to rotor shaft or pole pieces.

   b. Meter should indicate no continuity (meter should not move).

   c. If continuity does exist, complete rotor assembly must be replaced.

IMPORTANT: If alternator has output at low speeds, but no output at high speeds, rotor field winding may be shorting or grounding out, due to centrifugal force. Replace rotor if all other electrical components test good.

STATOR

IMPORTANT: Stator leads MUST BE disconnected from rectifier for this test.

1. Test stator for grounds (Test 1), using an ohmmeter (set on R x1 scale) as follows:

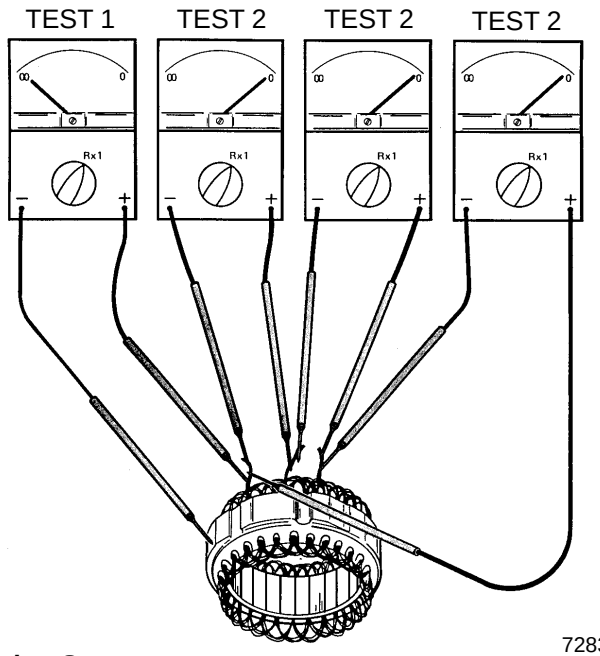
   a. Connect one lead of ohmmeter to one of the stator leads and the other lead to stator frame. Be sure that lead makes good contact with frame.

   b. Meter should indicate no continuity (meter should not move). If continuity does exist, stator is grounded and must be replaced.

2. Test for opens in stator (Test 2), using an ohmmeter (set on R x1 scale) as follows:

   a. Connect ohmmeter between each pair of stator windings (three different ways).

   b. Continuity should be present in all three cases (meter should move). If it does not, one or more of the windings are open and stator must be replaced.



72833

Testing Stator

3. A short in the stator is difficult to detect without special equipment, because of the low windings resistance. If all other electrical components test out good, and alternator fails to produce rated output, stator probably is shorted and should be replaced. Also, examine stator for heat discoloration, as this usually is a sure sign of a short.

Index

RECTIFIER AND DIODE ASSEMBLY

NOTE: *Failure of any component in tests following will require replacement of entire rectifier assembly.*

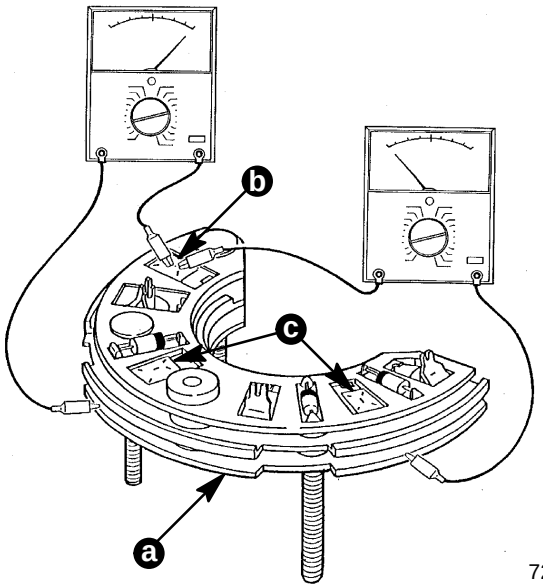
Negative (–) Rectifier

IMPORTANT: Rectifier MUST BE disconnected from stator for this test.

⚠CAUTION

DO NOT use a test instrument with more than a 12 volt source (in the following test), as rectifier may be damaged.

1. Connect one lead of an ohmmeter (set on R x1 scale) to negative (–) rectifier heat sink and the other lead to one of the rectifier terminals. Note the reading.
2. Reverse leads and again note reading.
3. Meter should indicate a high or infinite resistance (no meter movement) when connected one way and a low reading when connected the other. If both readings are high or infinite, rectifier is open. If both readings are low, rectifier is shorted.
4. Repeat Steps 1 through 3 for two other rectifiers in heat sink.
5. Replace assembly if any of the rectifiers is shorted or open.



72147

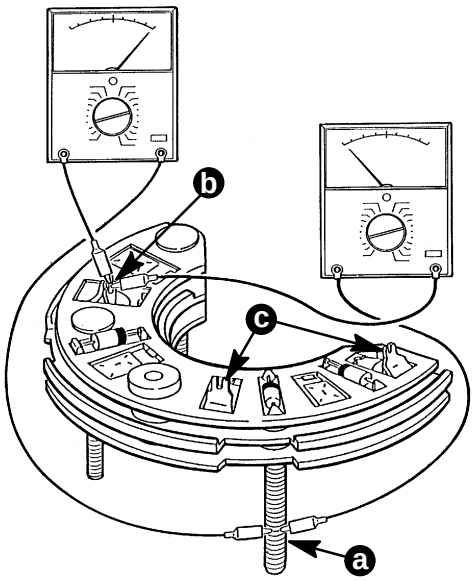
a - Heat Sink
b - Rectifier Terminal
c - Test These Two Rectifiers in Same Manner

Positive (+) Rectifier and Diodes

⚠CAUTION

DO NOT use a test instrument with more than a 12 volt source (in the following test), as rectifier may be damaged.

1. Connect one lead of an ohmmeter (set on R x1 scale) to 1/4 in. stud on positive (+) rectifier heat sink and the other lead to one of the rectifier terminals. Note the meter reading.
2. Reverse leads and again note reading.
3. Meter should indicate a high or infinite resistance (no meter movement) when connected one way and a low reading when connected the other. If both readings are high or infinite, rectifier is open. If both readings are low, rectifier is shorted.
4. Repeat Steps 1 through 3 for two other rectifiers in heat sink.



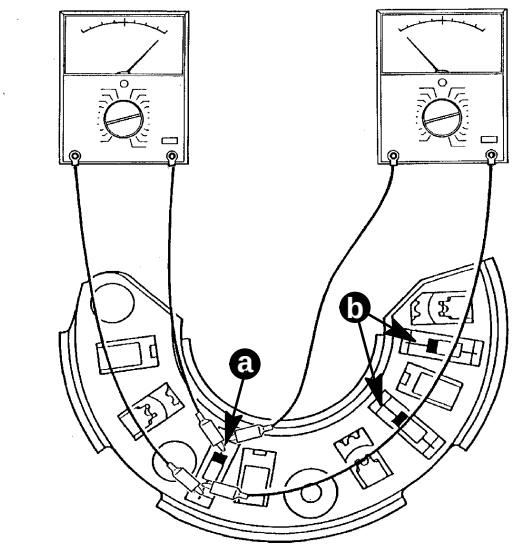
72834

a - Stud
b - Rectifier Terminal
c - Repeat Test between These Terminals and Stud

5. Replace assembly if any one of the rectifiers is shorted or open.

Index

6. Connect one lead of an ohmmeter (set on R x1) to the common side of the diode and the other lead to the other side, of one of the three diodes.



72148

a - Common Side of Diode Circuit Board
b - Repeat Test for These Two Diodes

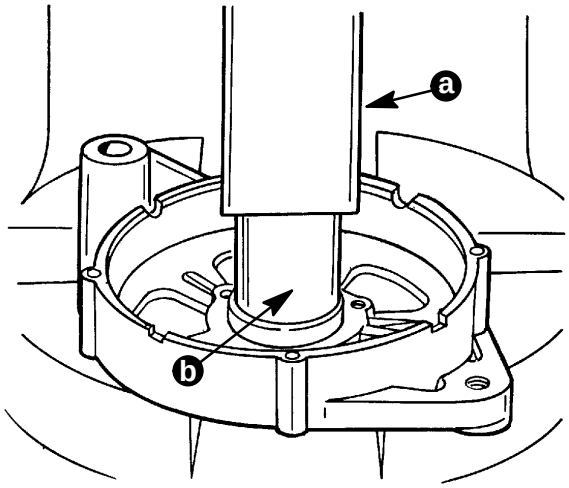
7. Reverse leads and again note reading.
8. Meter should indicate a high or infinite resistance (no meter movement) when connected one way and a low reading when connected the other. If both readings are high or infinite, diode is open. If both readings are low, diode is shorted.
9. Repeat Steps 6 through 8 for the other two diodes.
10. Replace rectifier assembly if any one of the diodes is shorted or open.

CONDENSER

1. Using magneto analyzer and accompanying instructions, perform the following condenser tests:
   a. Condenser Capacity Test (must be .5 mfd).
   b. Condenser Short or Leakage Test.
   c. Condenser Series Resistance Test.
2. Replace condenser if test results are not within specifications.

Reassembly

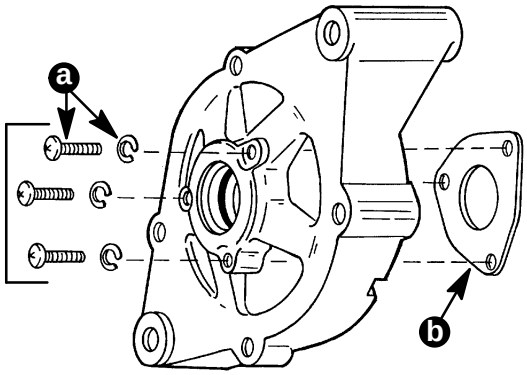
1. Install new front bearing into front end frame bearing bore using an arbor press. If necessary, use a bearing driver that contacts outer race only.



72835

a - Press
b - Mandrel

2. Install front bearing retaining plate using three Phillips head screws and lockwashers.



a - Phillips Head Screws and Lockwashers
b - Front Bearing Retaining Plate

72829

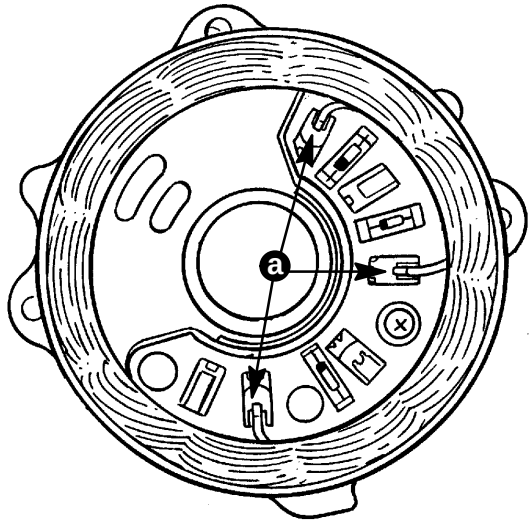
3. Slide front end frame over rotor.

IMPORTANT: DO NOT clamp vise on rotor pole pieces when tightening pulley nut (in next step), or pole pieces may be distorted.

4. Slide fan spacer onto rotor shaft. Install fan, pulley, lockwasher and nut on shaft. Clamp pulley in a vise, using protective jaws or an old oversize V-belt to protect pulley, and torque nut to specifications. Tighten vise only enough to allow tightening of nut, as excessive tightening may distort pulley.

Index

5. Assemble stator to rectifier by soldering the three leads to the three rectifier terminals.



72826

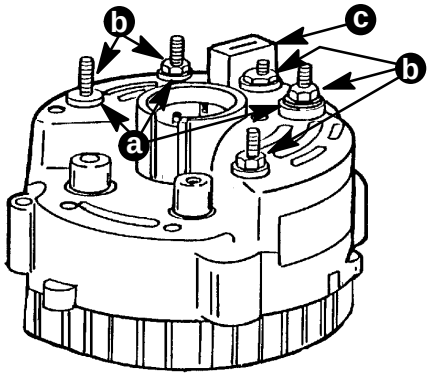
a - Stator Lead Connections

NOTE: *Be sure to connect leads to their original positions.*

6. Install assembled stator and rectifier assembly into rear end frame, aligning scribe marks on each (scribed during disassembly), and install Phillips head screw and washer to retain.

IMPORTANT: The insulating washers MUST BE installed as shown or damage to the alternator will result.

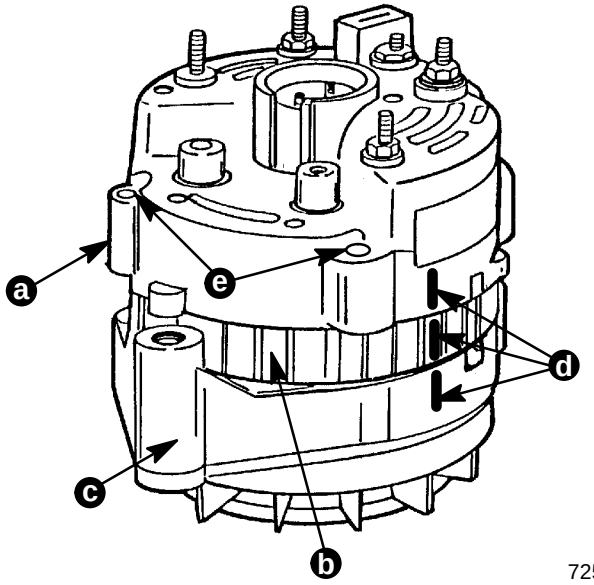
7. Position stator down with rear end frame up and reinstall insulators, nuts and condenser.



72561

a - Insulators (3)
b - Nuts (5) - ONE REMOVED
c - Condenser

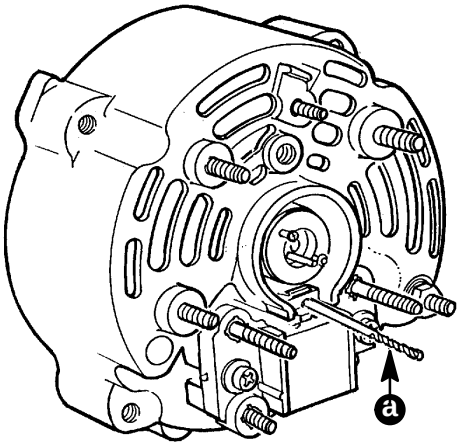
8. Position rear end frame and stator assembly over front end frame and rotor assembly and align scribe marks on each (scribed during disassembly). Hand-press end frames together, then install four screws. Tighten screws securely.



72561

a - Rear End Frame
b - Stator
c - Front End Frame
d - Scribe Marks
e - Insert Screws (4) (Two Hidden)

9. Depress brushes flush with top of brush holder and insert a #54 drill bit or smaller (.050 in.) into hole in brush holder to hold brushes compressed during reassembly.

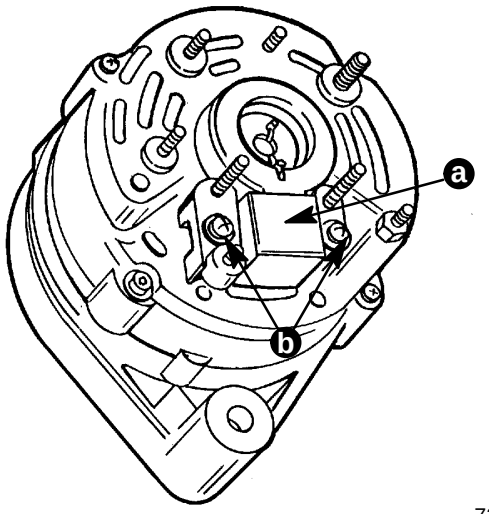


72836

a - Drill Bit

NOTE: *Shown with rubber gasket removed for clarity.*

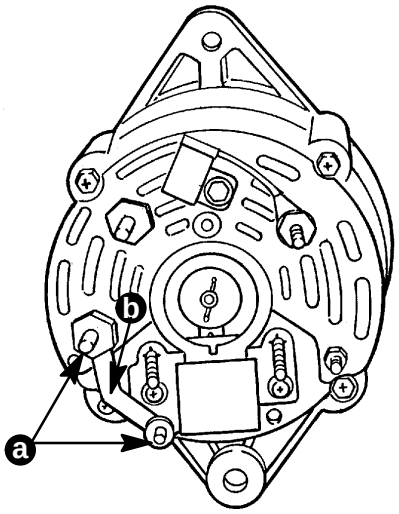
10. Install brush/regulator assembly in rear end frame cavity and secure with two mounting screws, as shown. Tighten screws securely. Remove drill bit to release brushes against slip rings.



72837

a - Brush/Regulator Assembly
b - Mounting Screws

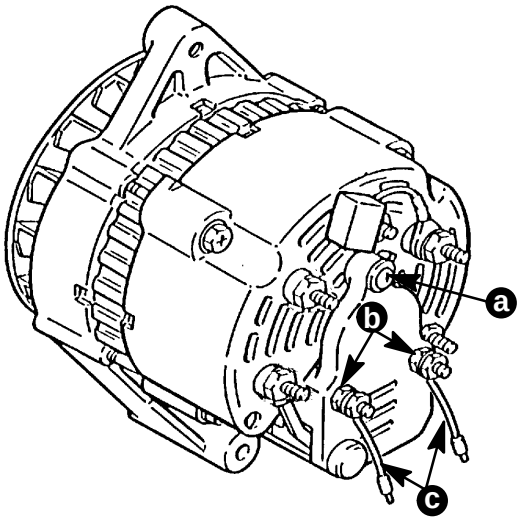
11. Install tie strap to rectifier stud and stud on brush/rectifier assembly. Tighten nuts securely.



72823

a - Studs
b - Tie Strap

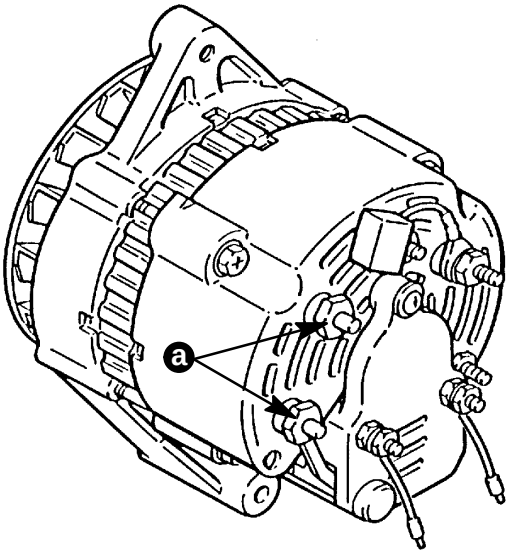
12. Install cover with one Phillips head screw and two nuts. Install two leads with nuts.



72963

a - Phillips Head Screw
b - Nuts (4)
c - Leads

13. Install insulator caps.

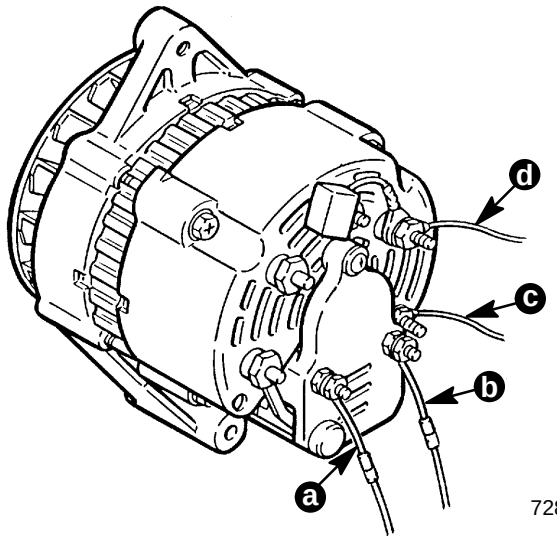


72078

a - Insulator Caps

Installation

1. Position alternator in mounting bracket and install mounting bolt, washers (if used), spacer and nut. Place washers (if used), on each side of spacer. DO NOT tighten securely at this time.
2. Fasten alternator brace to alternator with bolt, washers and spacer (if used). DO NOT tighten bolt at this time.
3. Position alternator drive belt on pulleys and adjust tension as explained under “Drive Belt Tension Adjustment.”
4. Reconnect wiring harness to alternator and negative battery cable to battery.



72838

a - Excitation Lead - PURPLE
b - Sensing Lead - RED/PURPLE
c - Ground Lead - BLACK
d - Output Lead - ORANGE

Prestolite 55 Amp Alternator

Replacement Parts Warning

⚠ WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Specifications

Description	Specification
Excitation Circuit	1.3-2.5 Volts
Current Output	50 Amp Minimum
Voltage Output	13.9-14.7 Volts
Condenser Capacity	.5 MFD
Minimum Brush Length	1/4 In. (6mm)

Tools/Sealants

Description	Part Number
Bearing Removal and Installation Kit	91-31229A5
Magneto Analyzer	91-76032
Universal Puller Plate	91-37241
Multi-Meter/DVA Tester	91-99750
Quicksilver Liquid Neoprene	92-27511--1
Ammeter (0-50 Amps)	Obtain Locally

Torque Specifications

Fastener Location	Lb In.	Lb. Ft.	N·m
Housing Screws	55		6.5
Pulley Nut		42	58
Front Bearing Screws			
Alternator Mount		35	48
Adjustment Bolt		16	28
All Other Fasteners	Tighten Securely		
V-Belt Tension (Note)	Depress 1/2 In. (13mm)		

NOTE: Depress belt with thumb at midway point between circulating pump pulley and alternator.

Description

The alternator has a rotor, which is supported in two end frames by ball bearings, and is driven by a pulley at approximately twice engine speed. The rotor contains a field winding that is enclosed between two multiple-finger pole pieces. The ends of the field winding are connected to two brushes (mounted in the rear end frame) which make continuous sliding (or slipping) contact with the slip rings. The current (flowing through the field winding) creates a magnetic field that causes the adjacent fingers of the pole pieces to become alternate north and south magnetic poles.

A 3-phase stator is mounted directly over the rotor pole pieces and between two end frames. It consists of three windings wound 120 degrees electrically out-of-phase on the inside of a laminated core. The windings are all connected together on one end, while the other ends are connected to a full-wave rectifier bridge.

The rectifier bridge contains six rectifiers which are arranged so that current flows from ground, through the stator and to the output terminal, but not in the opposite direction.

When current is supplied to the rotor field winding, and the rotor is turned, the movement of the magnetic fields created induces an alternating current into the stator windings. The rectifier bridge then changes this alternating current to direct current which appears at the output terminal. A diode trio also is connected to the stator windings to supply current to the regulator and the rotor field during operation.

Voltage output of the alternator is controlled by regulating the current supplied to the rotor field. This is accomplished by a transistorized voltage regulator that senses the voltage at the battery and regulates the field current to maintain alternator voltage within prescribed limits for properly charging the battery. Current output of the alternator does not require regulation, as maximum current output is self-limited by the design of the alternator. As long as the voltage is regulated within the prescribed limits, the alternator cannot produce excessive current. A cut-out relay in the voltage regulator also is not required, as the rectifier diodes (which allow current to flow in one direction only) prevent the battery from discharging back through the stator.

Due to the lack of residual magnetism in the rotor pole pieces, a small amount of current must be supplied to the rotor field to initially start the alternator charging. This is accomplished by means of an excitation circuit in the regulator which is connected to the ignition switch. Once the alternator begins to produce output, field current is supplied solely by the diode trio, as explained, preceding.

The alternator also is equipped with a fan (mounted on the rotor shaft) which induces air flow through the alternator to remove the heat created by the rectifiers and stator. A capacitor protects the rectifier system from high voltages and suppresses radio noise.

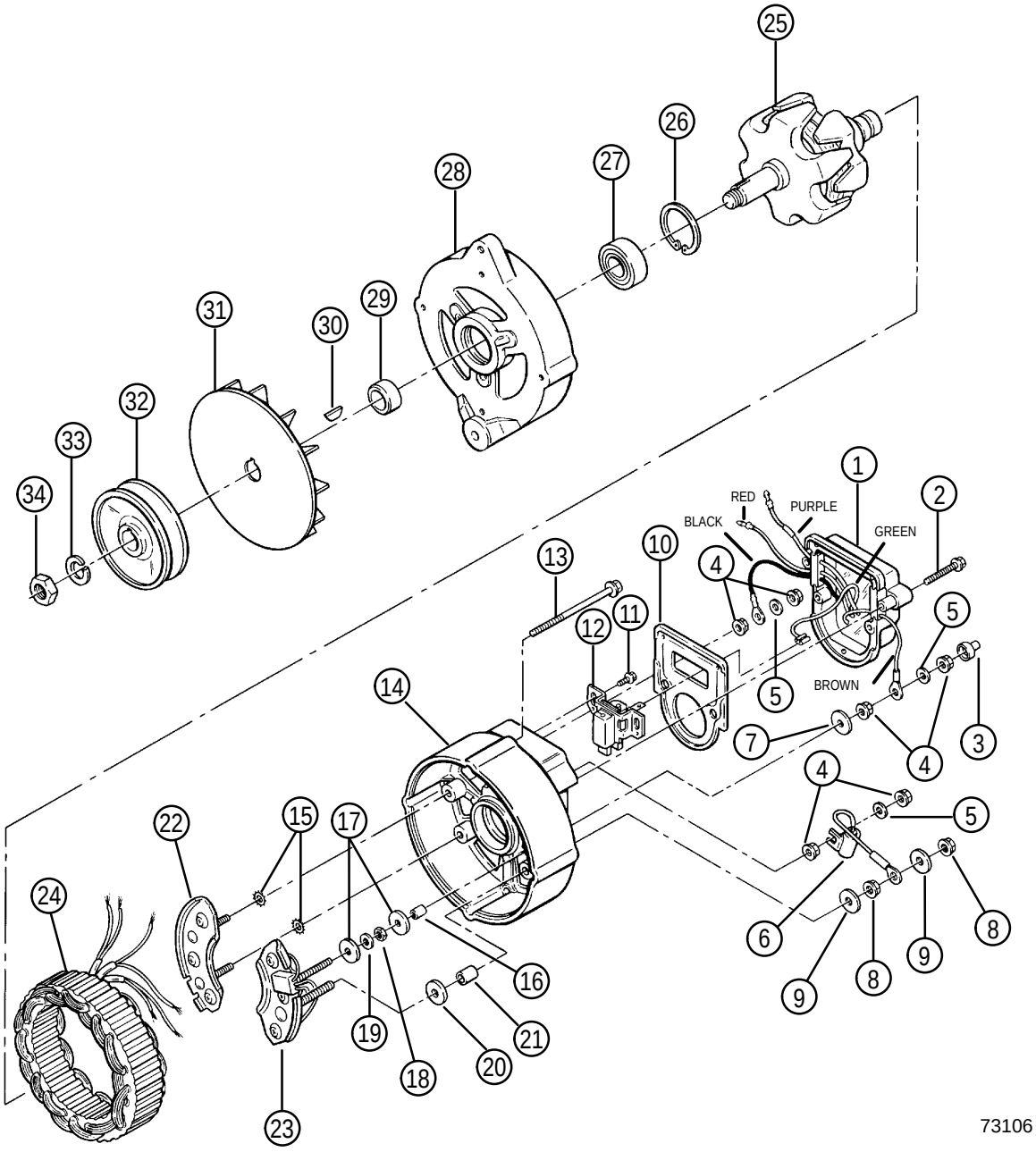
Precautions

The following precautions MUST BE observed when working on the alternator system. Failure to observe these precautions may result in serious damage to the alternator or alternator system.

1. DO NOT attempt to polarize the alternator.
2. DO NOT short across or ground any of the terminals on the alternator, except as specifically instructed in the “Troubleshooting Tests.”
3. NEVER disconnect the alternator output lead or battery cables when the alternator is being driven by the engine.
4. NEVER disconnect regulator lead from alternator regulator terminal when the alternator is being driven by the engine.
5. ALWAYS remove negative (–) battery cable from battery before working on alternator system.
6. When installing battery, BE SURE to connect the positive (+) battery cable to the positive (+) battery terminal and the negative (–) (grounded) battery cable to negative (–) battery terminal.
7. If a charger or booster battery is to be used, BE SURE to connect it in parallel with existing battery (positive to positive; negative to negative).

Index

Exploded View

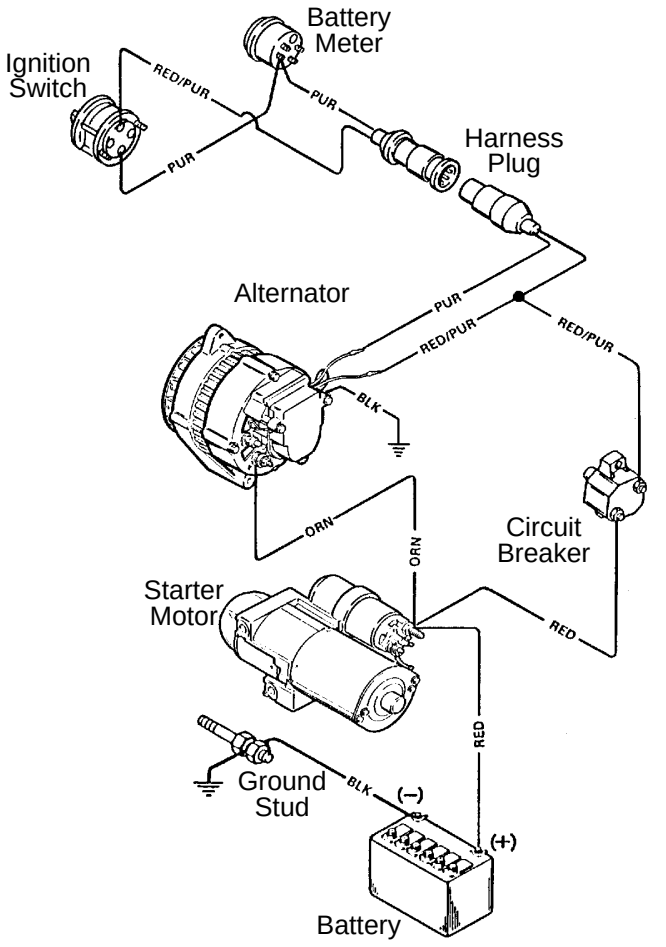


1 - Regulator and Leads
2 - Screws (4)
3 - Insulator Cap
4 - Nuts (6)
5 - Washers (3)
6 - Condenser
7 - Insulating Washer
8 - Nuts (2)
9 - Insulating Washers (2)
10 - Felt Gasket
11- Screws (2)
12 - Brush Assembly
13 - Screws (4)
14 - Rear End Frame
15 - Star Washers (2)
16 - Insulator
17 - Insulating Washers (2)
18 - Nut
19 - Washer
20 - Insulating Washer
21 - Insulator
22 - Negative Rectifier
23 - Positive Rectifier/Diode-Trio
24 - Stator
25 - Rotor and Slip Rings
26 - Snap Ring
27 - Bearing
28 - Front End Frame
29 - Fan Bushing
30 - Woodruff Key
31 - Fan
32 - Pulley
33 - Lockwasher
34 - Nut

Index

System Components

The alternator system consists of the alternator, battery, the ignition switch and the wiring which connects these components.



73079

Periodic Maintenance

The following maintenance check should be performed every 50 hours or 60 days (whichever comes first) in fresh water areas or every 25 hours or 30 days in salt water areas.

⚠CAUTION

Remove all battery cables from battery (before conducting the following check) to prevent accidentally shorting out electrical system.

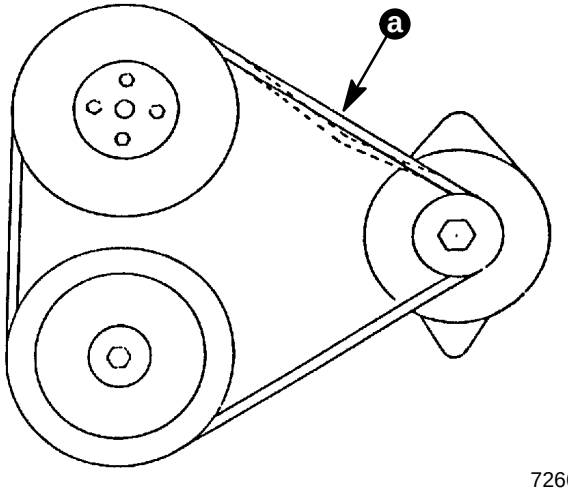
1. Inspect entire alternator system for corroded or loose connectors.
2. Check wiring for frayed or worn insulation.
3. Check alternator drive belt for excessive wear, cracks, fraying and glazed surfaces. Also, check drive belt tension and adjust, if necessary, as explained under “Drive Belt Tension Adjustment.”
4. Check alternator mounting bolts for adequate tightness.
5. Inspect slip ring end frame flame arrestor screen for debris and clean, if necessary, using compressed air or a cloth. Screen MUST BE clean, or alternator may overheat.

Drive Belt Tension Adjustment

Alternator

1. Install drive belt on pulleys and adjust tension as follows:

   a. Pivot alternator away from engine, as required, until correct tension is obtained as shown. Belt should depress 1/2 in. (13 mm).



72669

a - Check Point

   b. After obtaining correct tension, securely retighten alternator brace attaching bolts and alternator mounting bolts.

2. If a new drive belt has been installed, recheck belt tension after running for five minutes.

Troubleshooting Tests (Alternator on Engine)

Use the following tests in conjunction with the “Troubleshooting” in Section 1. Before proceeding with the tests, however, perform the following checks to eliminate possible problem areas. Also observe “Precautions,” preceding, to prevent damage to alternator system.

1. If problem is an undercharged battery, check to ensure that undercharged condition has not been caused by excessive accessory current draw or by accessories which have accidentally been left on. Also, check that undercharged condition has not been caused by running engine at too low a speed for extended periods of time.
2. Check physical condition and state of charge of battery, as outlined in “Battery - Storage” in Section 4A. Battery MUST BE at least 75% (1.230 specific gravity) of fully charged to obtain valid results in the following tests. If not, charge battery before testing system.
3. Inspect entire alternator system wiring for defects. Check all connections for tightness and cleanliness, particularly battery cable clamps and battery terminals.
4. Check alternator drive belt for excessive wear, cracks, fraying and glazed surfaces and replace if necessary. Also, check drive belt tension and adjust if necessary, as outlined under “Drive Belt Tension Adjustment.”

Circuitry Test

Perform the following tests, using a 0-20 volt DC voltmeter, to check that all of the circuits between the alternator and the other components within the alternator system are in good condition.

⚠ WARNING

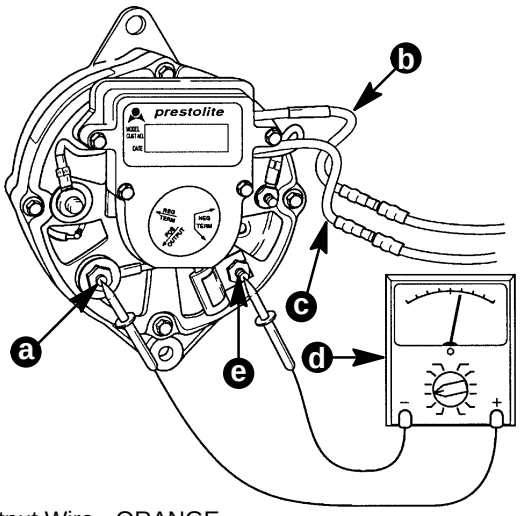
Be sure that engine compartment is well-ventilated and that there are no gasoline vapors present (during the test) to prevent the possibility of an explosion and/or a fire, should a spark occur.

ALTERNATOR OUTPUT TEST

1. Connect positive (+) voltmeter lead to alternator output terminal (orange wire) and negative (–) lead to a ground terminal on alternator. With engine running about 1500 RPM and all accessories turned on, voltage should be between 13 [illegible]3.

Index

2. If voltage output does not fall within specifications, alternator should be tested for probable cause and disassembled for repair.

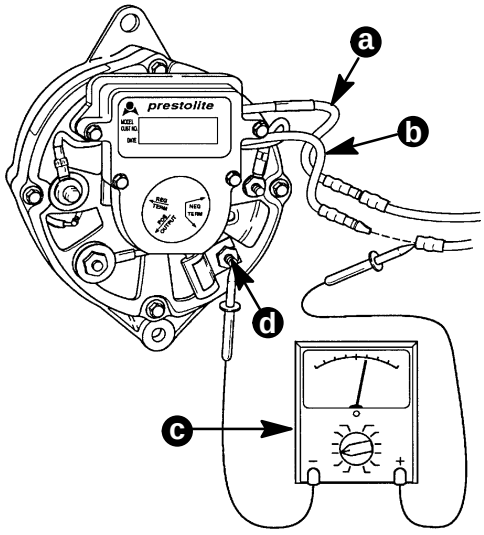


73081

a - Output Wire - ORANGE
b - Excitation Wire - PURPLE
c - Sensing Wire - RED/PURPLE
d - Voltmeter (0-20 Volts)
e - Ground

HARNESS VOLTAGE TEST

With ignition off, unplug red/purple wire and check for battery voltage at harness wire. No voltage at harness wire indicates wiring harness is “open” and should be repaired or replaced.

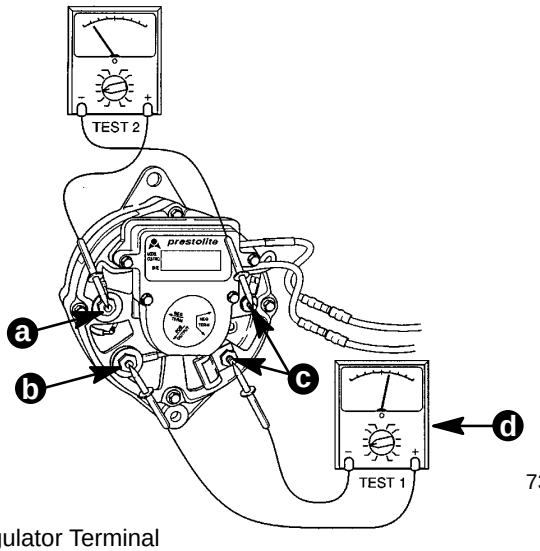


73082

a - Excitation Wire - PURPLE
b - Sensing Wire - RED/PURPLE
c - Voltmeter (0-20 Volts)
d - Ground

OPEN DIODE-TRIO TEST

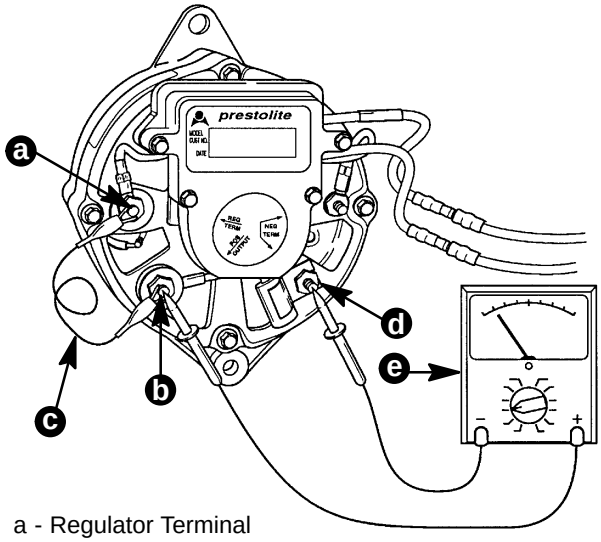
1. With ignition on and engine not running, check for battery voltage at alternator output terminal (Test 1) and 1.5 to 3.0 volts at regulator terminal (Test 2).



73083

a - Regulator Terminal
b - Output Terminal
c - Ground
d - Voltmeter (0-20 Volts)

2. Connect a jumper wire between regulator and output terminal. Start engine and run at idle. If charging voltage (13.8-14.8 volts) is present at output terminal, the diode-trio is probably defective and alternator should be removed for repair.



73084

a - Regulator Terminal
b - Output Terminal
c - Jumper Lead
d - Ground
e - Voltmeter (0-20 Volts)

Index

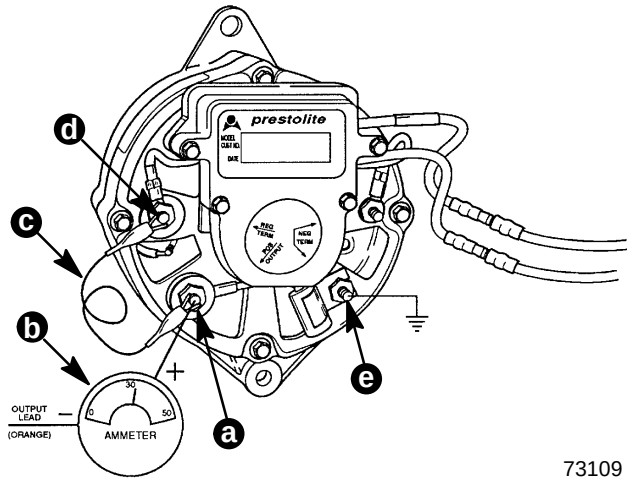
CURRENT OUTPUT TEST

Perform this test to check if alternator is capable of producing rated current output, using a 0-50 amp DC ammeter.

⚠ WARNING

Be sure that engine compartment is well-ventilated and that there are no gasoline vapors present (during the test) to prevent the possibility of an explosion and/or a fire, should a spark occur.

1. Disconnect negative (–) battery cable from battery.
2. Disconnect ORANGE lead from alternator output terminal and connect ammeter in series between lead and output terminal. Connect positive (+) side of ammeter toward output terminal.
3. Reconnect negative battery cable.
4. Remove coil wire from distributor cap tower and ground it to block. Turn on all accessories and crank engine over with starter motor for 15-20 seconds.
5. Turn off accessories and reinstall coil hi-tension lead. Start engine and adjust engine speed to 1500-2000 RPM. Quickly observe ammeter. Reading should be at least 30 amps.
6. If reading is low, stop engine and connect a jumper wire between alternator output terminal and regulator terminal. Repeat Steps 4 and 5.
7. If reading is now within specifications, diodes are faulty. Disassemble alternator and replace rectifier as explained under “Alternator Repair,” following, to determine if fault is in regulator or alternator.
8. If reading is still low with jumper wire connected, perform “Voltage Output Test,” following, to determine if fault is in regulator or alternator.



73109

a - Output Wire - ORANGE
b - Ammeter (0-50 Amps)
c - Jumper Lead
d - Regulator Terminal
e - Ground

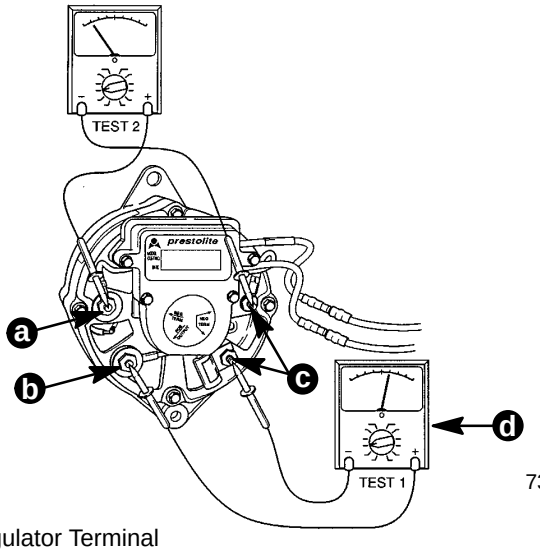
OPEN REGULATOR TEST

IMPORTANT: This test requires removal of regulator.

⚠CAUTION

To prevent electrical system damage and/or sparks, disconnect battery cables at battery.

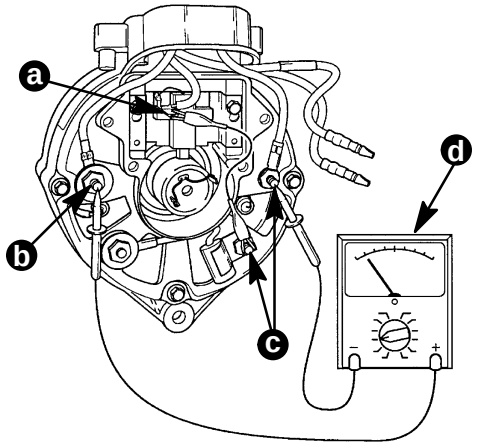
1. Remove insulator cap from regulator terminal.
2. With ignition switch on and engine not running, check for battery voltage at alternator output terminal (Test 1) and regulator terminal (Test 2).



73083

a - Regulator Terminal
b - Output Terminal
c - Ground
d - Voltmeter (0-20 Volts)

3. Remove the four screws which secure the regulator to the alternator.
4. Connect a jumper wire between field terminal (GREEN WIRE) and ground/ If 1.5 to 3.0 volts are present at regulator terminal, regulator is defective. If voltage is not present at regulator terminal, there is an open field circuit (brushes slip rings, etc.). Remove alternator for repair.



73086

a - Field Terminal (GREEN WIRE)
b - Regulator Terminal
c - Ground
d - Voltmeter (0-20 Volts)

NOTE: *Felt gasket shown removed for visual clarity.*

Alternator Repair

⚠WARNING

Be sure that engine compartment is well-ventilated and that there are no gasoline vapors present to prevent the possibility of an explosion and/or a fire, should a spark occur.

Removal

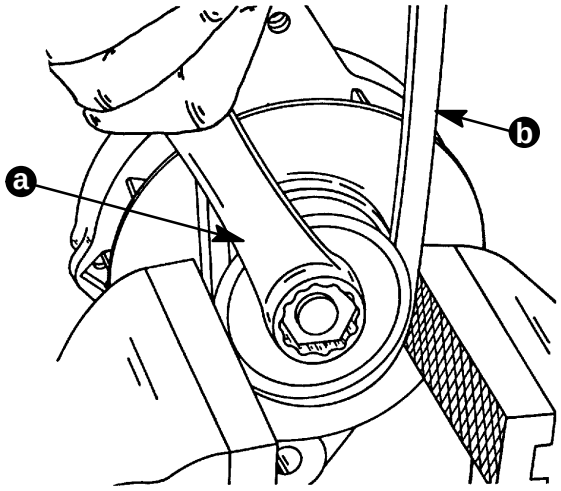
⚠CAUTION

To prevent electrical system damage and/or sparks, disconnect battery cables at battery.

1. Disconnect battery cables from battery.
2. Disconnect wiring harness from alternator.
3. Remove alternator belt.
4. Remove alternator.

Disassembly

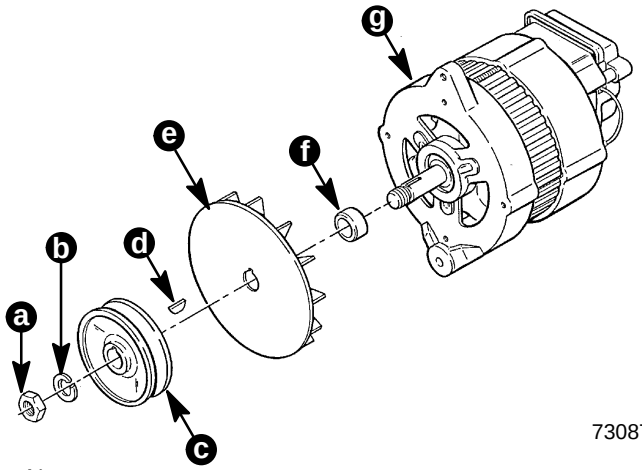
1. Using an oversized V-belt to protect the pulley, clamp alternator in vise as shown. Remove pulley nut and lockwasher.



72828

a - 7/8 In. Wrench
b - Oversized V-Belt to Protect Pulley

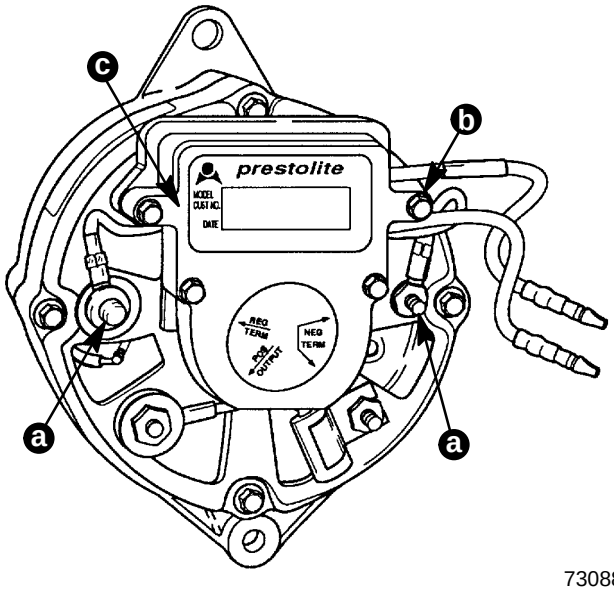
2. Remove pulley, fan, woodruff key and spacer.



73087

a - Nut
b - Lockwasher
c - Pulley
d - Woodruff Key
e - Fan
f - Spacer
g - Alternator

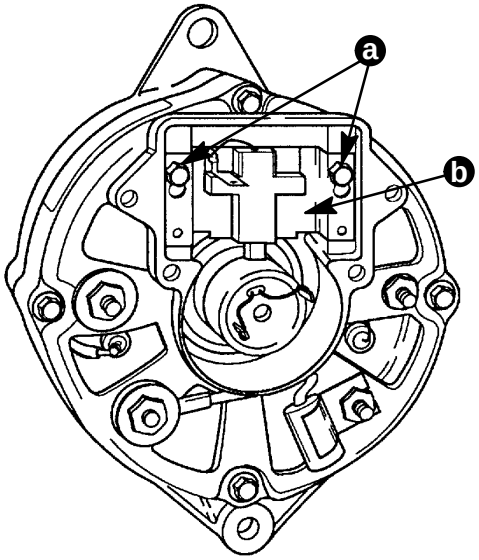
3. Disconnect regulator leads from terminals on rear end frame. Remove four regulator attaching screws, then pull regulator away from rear end frame and disconnect field lead.



73088

a - Regulator Leads (2)
b - Screws (4)
c - Regulator

4. Remove brush holder.



73090

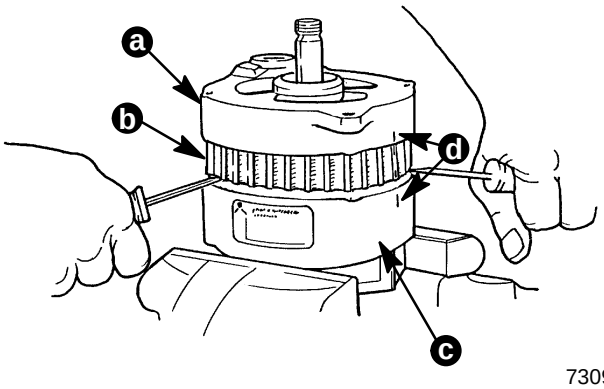
a - Attaching Screws
b - Brush Holder

5. Note location of remaining insulating washers and nuts and remove.
6. Scribe a mark on rear end frame, stator and front end frame to ensure proper reassembly later.
7. Remove the four screws which secure end frames and stator together.

⚠CAUTION

Do not insert screwdriver blades deeper than 1/16 in. (1.58 mm) to avoid damaging stator windings.

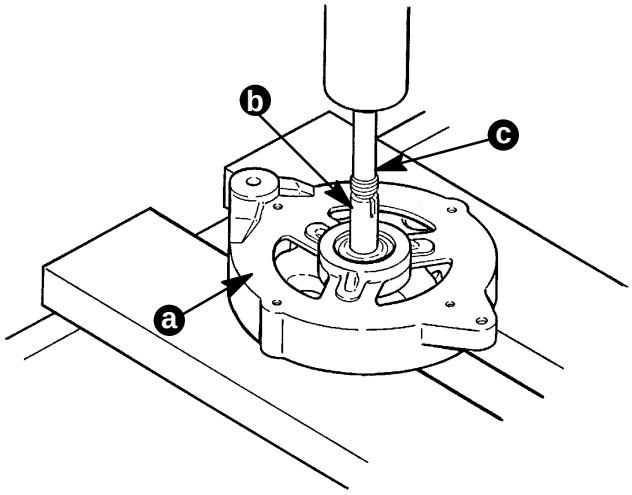
8. Using a suitable holding fixture, separate front end frame and stator assembly from rear end frame using two thin blade screwdrivers (positioned 180 degrees apart from each other) at the locations shown.



73091

a - Front End Frame
b - Stator
c - Rear End Frame
d - Scribe Marks

9. While supporting front housing, use an arbor press to remove rotor from front end frame.



73092

a - Front Housing
b - Rotor Shaft
c - Bearing Driver

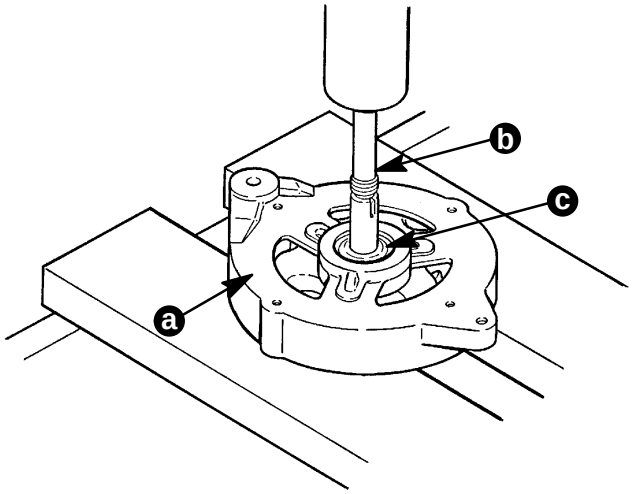
Cleaning and Inspection

1. Clean all parts with a clean, soft cloth. Do not use solvent, or electrical components may be damaged.
2. Inspect the following:
   a. **Brush Set** - Inspect for cracked porcelain casing, damaged brush leads, poor brush springs or worn brushes. Replace brush set if brushes are less than 3/16 in (5 mm) long.
   b. **Rotor** - Inspect for stripped threads, scuffed pole piece fingers or damaged bearing surfaces (because of bearing turning on shaft).
   c. **Rotor Slip Rings** - Clean slip rings with 400 grain (or finer) polishing cloth. Blow off dust with compressed air. Inspect slip rings for grooves, pits, flat spots or out-of-round [.002 in. (.05 mm) maximum]. Replace if defective.
   d. **Rotor Shaft Bearings** - Inspect for damaged seals, lack of lubrication, discoloration (from overheating) or excessive side or end play. Hold inner race of bearings while turning outer race. Bearing should turn freely without binding or evidence of rough spots.
   e. **Stator** - Inspect for damaged insulation or wires; also inspect insulating enamel for heat discoloration, as this is usually a sign of a shorted or grounded winding or a shorted diode.
   f. **Regulator** - Inspect leads for damaged insulation.
   g. **Front and Rear Housings** - Inspect for cracks, distortion, stripped threads or wear in bearing bore (from bearing outer race spinning in bore). Replace if defective.
   h. **Fan** - Inspect for cracked or bent fins, broken welds or worn mounting hole (from fan spinning on shaft).
   i. **Pulley** - Inspect pulley mounting bore and for wear. Inspect drive surface of pulley sheaves for trueness, excessive wear, or corrosion. Repair damaged surfaces, if possible, with a fine file and a wire brush, or replace pulley. Drive surfaces must be true and smooth, or drive belt wear will be greatly accelerated.
   j. **Alternator** - If alternator has output at low speeds, but no output at high speeds, rotor field winding may be shorting or grounding out because of centrifugal force. Replace rotor, if all other electrical components test good.

Front Bearing

Removal

1. Remove snap ring.
2. Use an arbor press to remove bearing from housing.

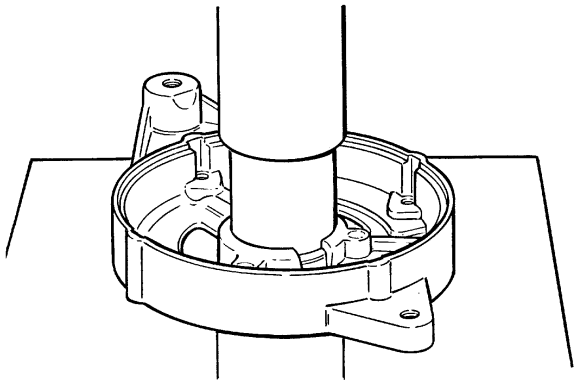


73093

a - Front Housing
b - Bearing Driver
c - Bearing

Installation

1. Using an arbor press, press on outer race of new bearing until fully seated in housing.



73094

a - Press
b - Mandrel

2. Install snap ring to retain bearing.

Index

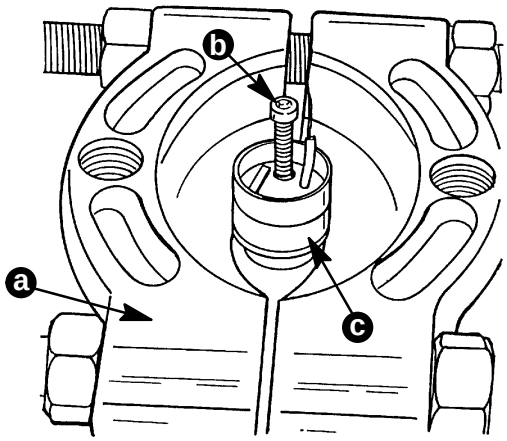
Slip Rings/Rear Bearing

Removal

1. Unsolder wires and carefully unwind them from slip ring terminals.

IMPORTANT: Do not damage rotor wires when removing slip rings or bearing.

2. Install a universal puller plate between bearing and slip rings. Insert a 10 x 1 in. cap screw into opening of slip ring assembly.



73095

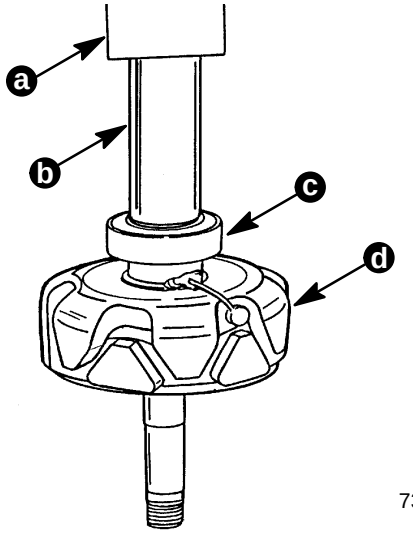
a - Universal Plate Puller
b - Cap screw
c - Slip Rings

3. Using an arbor press, push against cap screw to remove slip rings.
4. Install a universal puller plate under bearing.
5. Using an arbor press, remove bearing.

Installation

1. Press new rear bearing all the way onto rotor shaft (until inner race contacts shoulder) with an arbor press and a bearing driver that contacts inner bearing race only, as shown. Use extreme care to prevent damage to field winding leads.

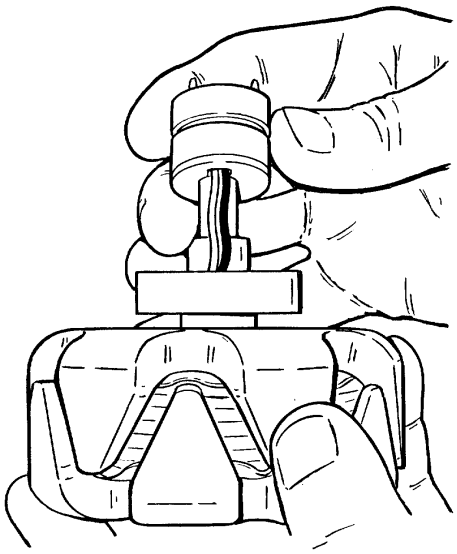
IMPORTANT: Be sure to support rotor on end of shaft and not on pole pieces, as pole pieces are only press-fit onto shaft.



73096

a - Arbor Press
b - Bearing Driver
c - Bearing
d - Rotor

2. Insert wires through hole in slip rings as shown.

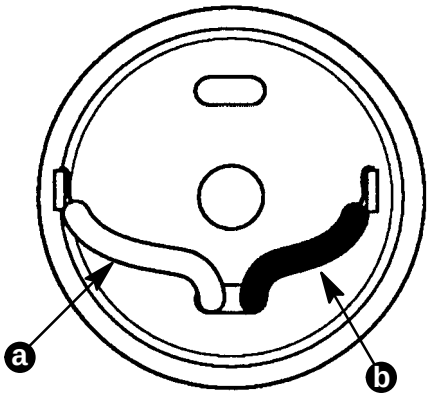


73097

Index

IMPORTANT: Press on the center of slip rings only. Do not bend terminals or pinch wires.

3. Using an arbor press, install slip rings. Press on center of slip rings until they contact shoulder of rotor.
4. Carefully wrap WHITE wire around outer slip ring terminal, and BLUE wire around inner slip ring terminal. Solder wires in place.



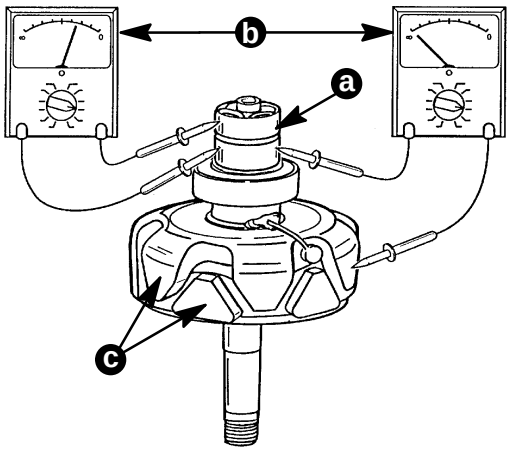
73098

a - WHITE Wire
b - BLUE Wire

Component Testing

Rotor

1. Test rotor field circuit for grounds, using an ohmmeter (set on Rx1 scale) as follows:
   a. Connect one lead of ohmmeter to either slip ring and the other lead to rotor shaft or pole pieces.
   b. Meter should indicate no continuity (meter should not move).
   c. If continuity does exist, rotor field circuit is grounded. Inspect slip ring terminals to be sure that they are not bent and touching rotor shaft. Also be sure that excess solder is not grounding terminals to rotor shaft. If cause for ground cannot be found, unsolder field winding leads from slip ring terminals and connect ohmmeter between one of the leads and rotor shaft or pole pieces. If continuity still exists, replace rotor assembly. If continuity is eliminated, replace slip rings.



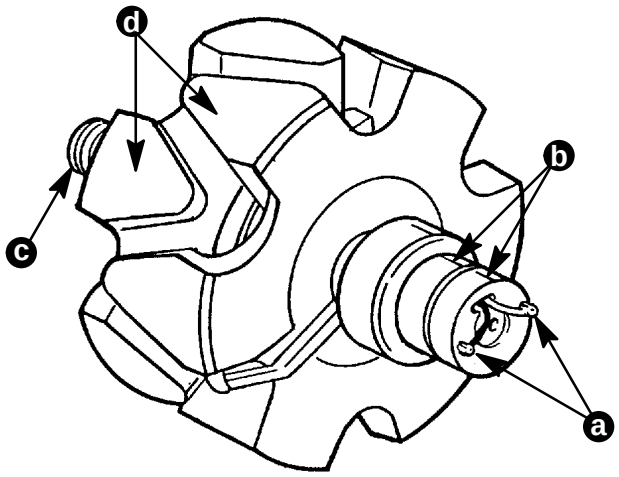
73099

a - Slip Rings
b - Ohmmeter with Leads
c - Pole Pieces

2. Test rotor field circuit for opens, shorts or high resistance, using an ohmmeter (set on Rx1 scale) as follows:
   a. Connect one ohmmeter lead to each slip ring.
   b. Ohmmeter reading should be 4.1 to 4.7 ohms with rotor at room temperature 70-80°F (21-26°C).

c. If reading is high or infinite (no meter movement), high resistance or an open exists in the field circuit. Check for poor connections between field winding leads and slip ring terminals. If cause for open or high resistance cannot be found, connect ohmmeter directly to slip ring terminals. If correct reading is now obtained, replace slip rings. If reading is still high or infinite, replace complete rotor assembly.

d. If reading is low, a short exists in the field circuit. Inspect slip rings to be sure that they are not bent and touching outer slip ring. Also be sure that excess solder is not shorting terminals to aft slip ring. If cause for short cannot be found, unsolder field winding leads from slip ring terminals and connect ohmmeter directly to leads. If correct reading is now obtained, slip rings are shorted and must be replaced. If reading is still low, rotor field windings are shorted, and complete rotor assembly must be replaced.



73112

a - Field Winding Leads
b - Slip Rings
c - Rotor Shaft
d - Pole Pieces

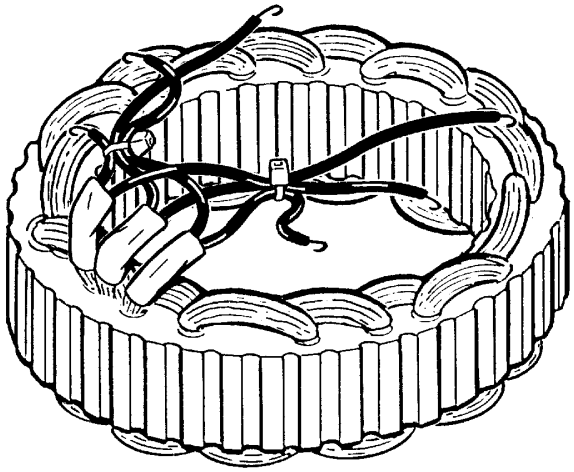
Stator

IMPORTANT: Stator leads MUST BE disconnected from rectifiers and diode-trio for this test.

⚠CAUTION

Excessive heat from de-soldering may cause damage to rectifiers or diode-trio assembly when disconnecting leads.

1. Test stator for grounds, using an ohmmeter (set on Rx1 scale) as follows:
   a. Connect one lead of ohmmeter or test lamp to one of the stator leads and the other lead to stator frame. Be sure that lead makes good contact with frame.
   b. Meter should indicate no continuity (meter should not move). If continuity does exist, stator is grounded and must be replaced.



73101

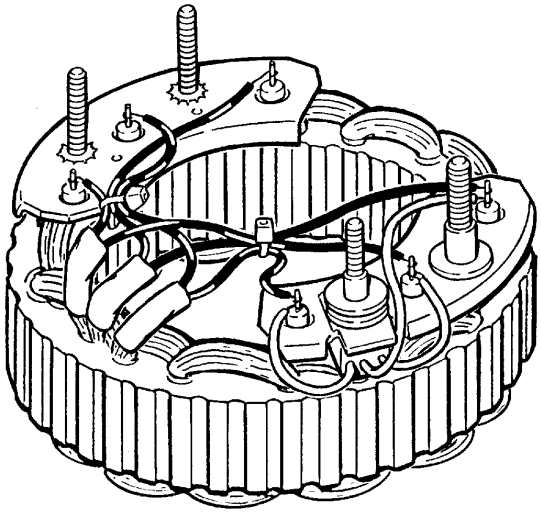
NOTE: *It is necessary to test only three of the six leads on EITHER side of the stator as the leads are interconnected in the windings.*

2. Test for opens in stator, using an ohmmeter (set on Rx1 scale) as follows:
   a. Connect ohmmeter or test lamp between each pair of stator windings (3 different ways).
   b. Continuity should be present in all three cases (meter should move). If it does not, one or more of the windings are open and stator must be replaced.

3. A short in the stator is difficult to detect without special equipment, because of the low windings resistance. If all other electrical components test out good, and alternator fails to produce rated output, stator probably is shorted and should be replaced. Also, examine stator for heat discoloration, as this usually is a sign of a short.

Positive/Negative Rectifier and Diode-Trio Assembly

IDENTIFICATION



73100

NEGATIVE (–) RECTIFIER

⚠CAUTION

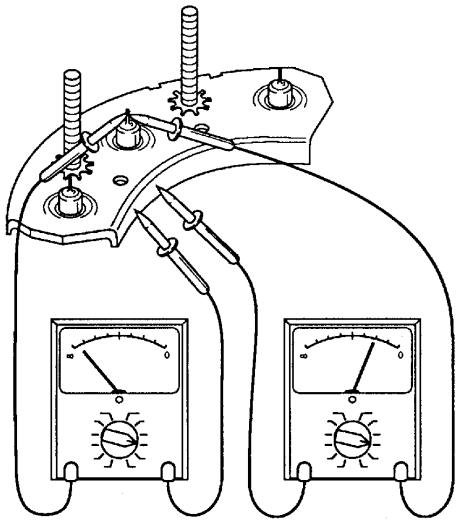
Do not use a test instrument with more than a 12-volt source in the following test, as rectifier may be damaged.

IMPORTANT: Rectifier MUST BE disconnected from stator for this test.

⚠CAUTION

Excessive heat from de-soldering may cause damage to rectifier when disconnecting leads.

1. Identify the leads prior to removal so they can be reassembled to their original positions.
2. Using an ohmmeter (set on Rx1 scale), check for continuity between rectifier terminal and heat sink. Reverse ohmmeter leads and recheck. Continuity should be observed in one direction (polarity) only.
3. Check other two rectifiers in same manner.
4. Replace assembly if any of the rectifiers is shorted or open.



73102

POSITIVE (+) RECTIFIER AND DIODE-TRIO

⚠CAUTION

Do not use a test instrument with more than a 12-volt source in the following test, as rectifier may be damaged.

IMPORTANT: Rectifier MUST BE disconnected from stator for this test.

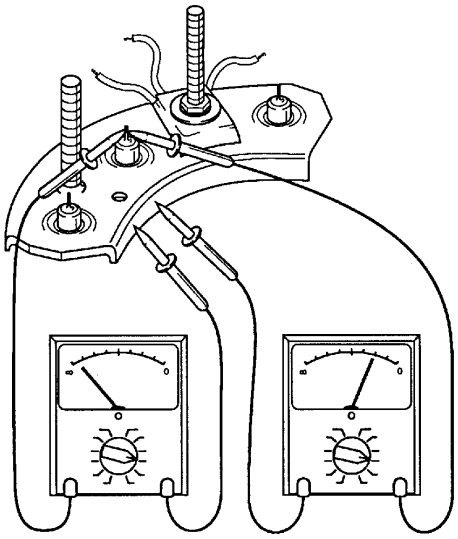
⚠CAUTION

Excessive heat from de-soldering may cause damage to rectifier or diode-trio assembly when disconnecting leads.

1. Identify the leads prior to removal so they can be reassembled to their original positions.
2. Using an ohmmeter (set on Rx1 scale), check for continuity between rectifier terminal and heat sink. Reverse ohmmeter leads and recheck. Continuity should be observed in one direction (polarity) only.
3. Check other two rectifiers in same manner.

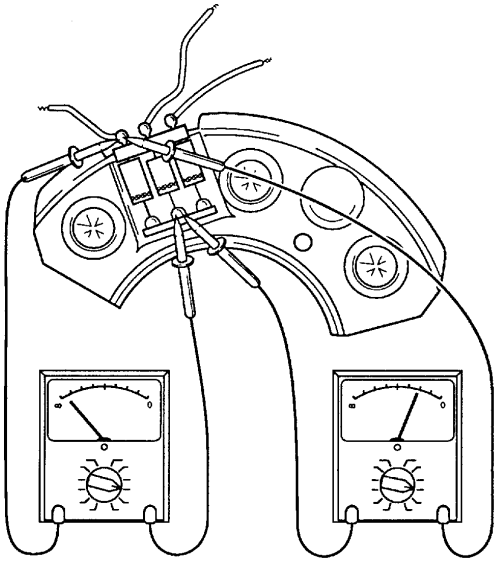
Index

4. Replace assembly if any of the rectifiers is shorted or open.



73103

5. Using an ohmmeter (set on Rx1 scale), check for continuity between the common side of the diodes and one of the terminals on other side of the diode. Reverse ohmmeter leads and recheck. Continuity should be observed in one direction (polarity) only.
6. Check other two diodes in same manner.
7. Replace diode-trio if any of the diodes is shorted or open.



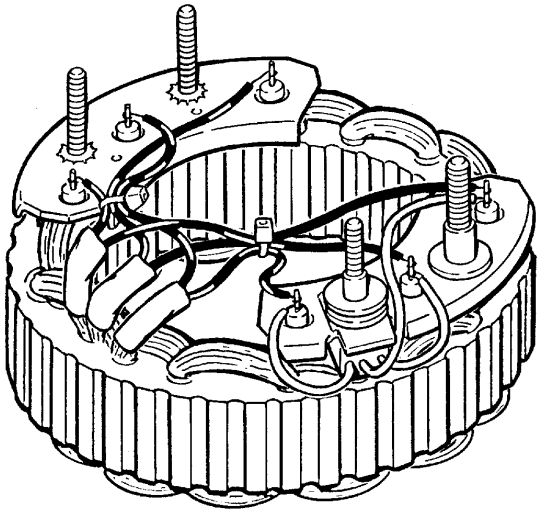
73104

Condenser

1. Using Magneto Analyzer (91-76032) and accompanying instructions, perform the following condenser tests:
   a. Condenser Capacity Test (must be .5 mfd)
   b. Condenser Short or Leakage Test
   c. Condenser Series Resistance Test
2. Replace condenser if test results are not within specifications.

Reassembly

1. Solder positive/negative rectifier and diode-trio assembly to stator. Connect leads to original location as identified during disassembly.

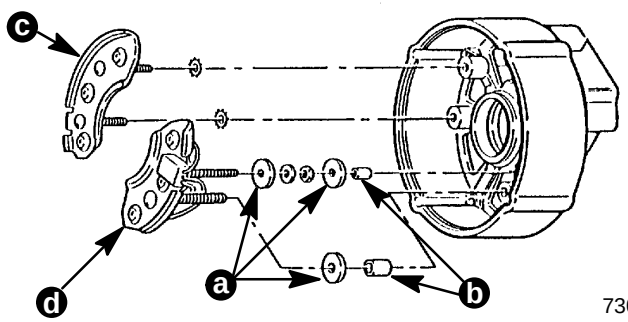


73100

2. Install rotor to front end frame.

Index

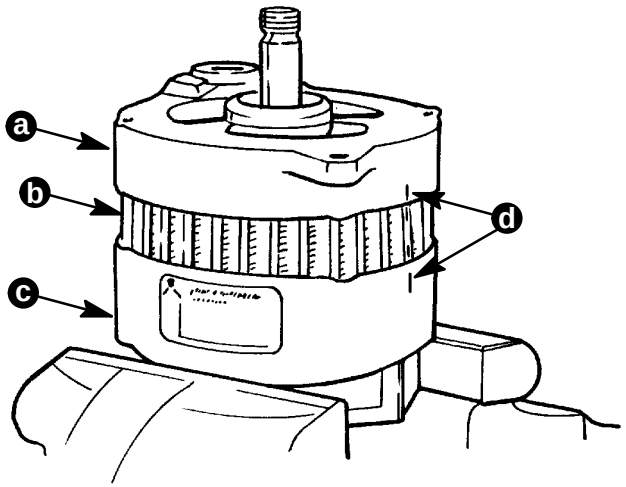
IMPORTANT: The insulators MUST BE installed as shown or damage to the alternator will result.



73085

a - Insulating Washers
b - Insulators
c - Negative Rectifier
d - Positive Rectifier/Diode-Trio

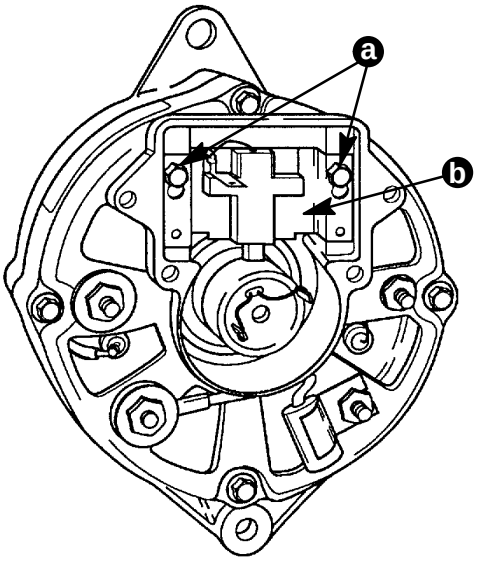
3. Position rear end frame and stator assembly with insulators over front end frame and rotor assembly. Align scribe marks on each (scribed during disassembly). Hand press end frames together, then install four screws. Torque screws to 50-60 lb. in. (5.6-6.7 N·m).



73105

a - Front End Frame
b - Stator
c - Rear End Frame
d - Scribe Marks

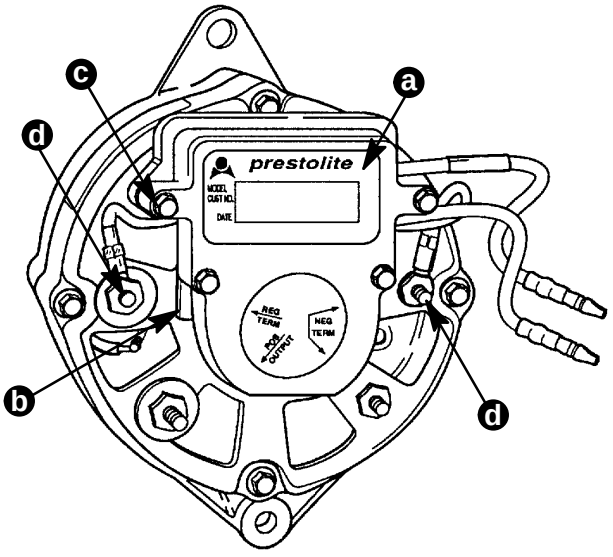
4. Install brush holder into rear end frame and slide forward to depress brushes against slip ring. Insert two screws and tighten securely.



73090

a - Attaching Screws
b - Brush Holder

5. Attach field lead to brush assembly. Install regulator and felt gasket to rear end frame. Install four screws and tighten securely. Reconnect regulator terminal leads to appropriate stud on rear end frame.

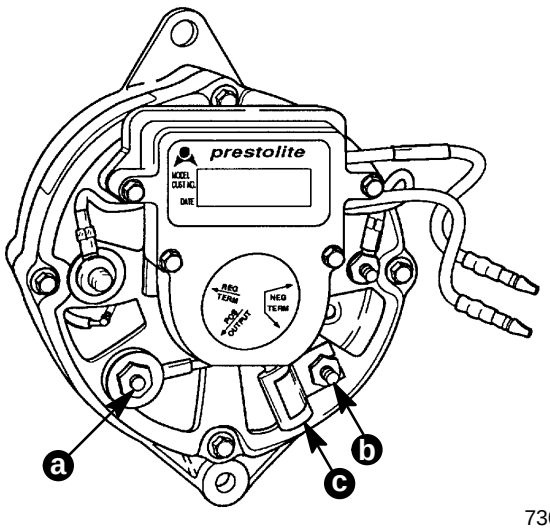


73107

a - Regulator
b - Felt Gasket
c - Screws (4)
d - Regulator Leads

Index

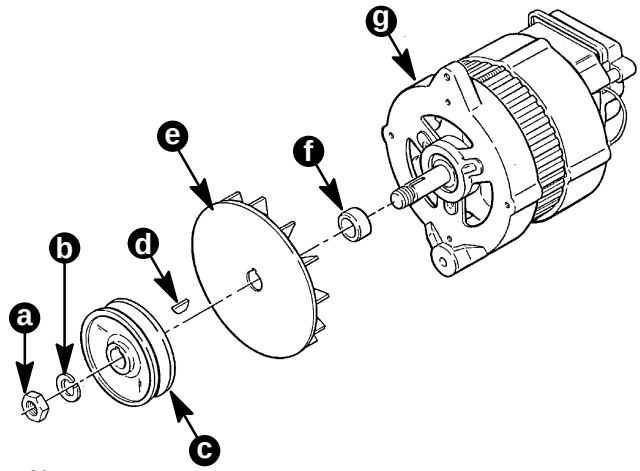
6. Place condenser on ground terminal and lead on output terminal. Install insulator cap on regulator terminal.



73088

a - Output Terminal
b - Ground Terminal
c - Condenser

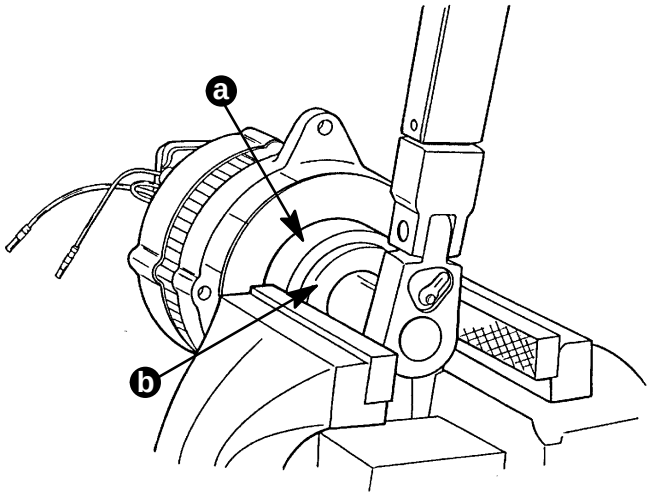
7. Install spacer, woodruff key, fan, pulley, lockwasher and nut.



a - Nut
b - Lockwasher
c - Pulley
d - Woodruff Key
e - Fan
f - Spacer
g - Alternator

73087

8. Using an oversized belt to protect the pulley, clamp alternator in vise as shown. Tighten pulley nut to 35-50 lb. ft. (48-68 N·m).



73108

a - Oversized Belt
b - Pulley

Installation

1. Install alternator on engine.
2. Install alternator belt and adjust as outlined under “Drive Belt Tension Adjustment.”
3. Tighten mounting bolts to specifications.
4. Reconnect wiring harness to alternator and negative battery cable to battery.
5. Coat all terminal lead connections with Quicksilver Liquid Neoprene.

Index

Battery Isolators

Dual Battery Charging Systems Using a Battery Isolator

Battery isolators allow the addition of an auxiliary (second) battery to the MerCruiser electrical system. The auxiliary battery is primarily used as a power source for various accessories installed on the boat. The battery isolator will allow the alternator to charge both the cranking and auxiliary batteries at the same time while preventing accessories, connected to the auxiliary battery, from drawing power from the cranking battery.

Mercury Marine does not manufacture any battery isolator systems. Battery isolators must be bought from an outside manufacturer. Mercury Marine suggests following the manufacturer's instructions carefully.

IMPORTANT: Alternators used on MerCruiser engines ARE NOT equipped with an isolation diode.

⚠ CAUTION

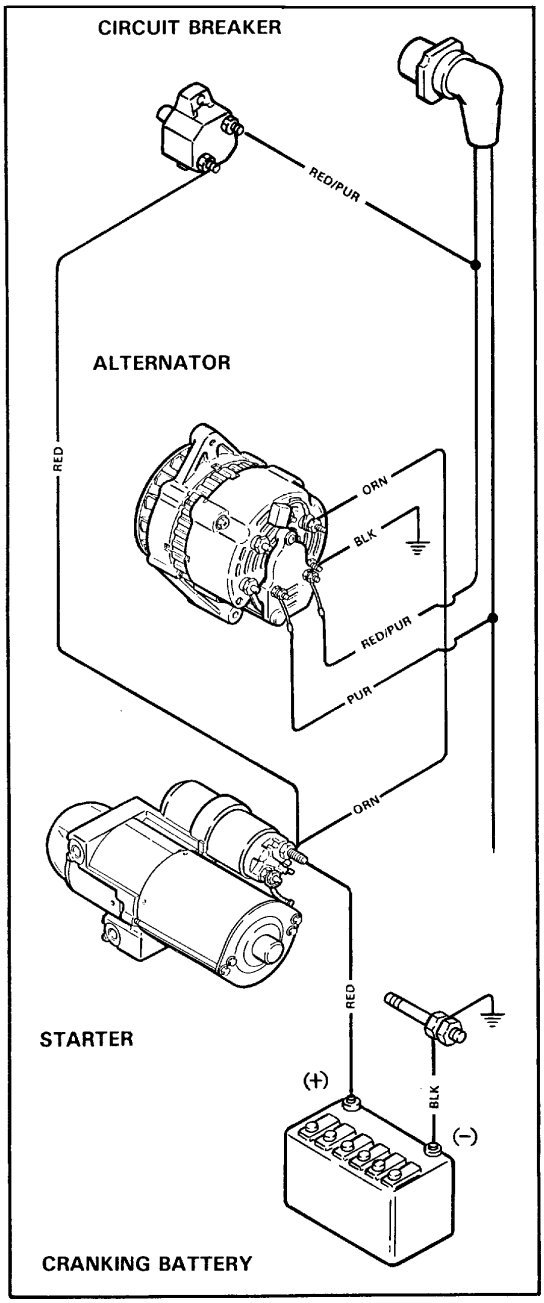
Follow battery isolator manufacturer's instructions for wire gauge. Battery isolator installation must conform to BIA Low Voltage Wiring Standard No. 125-79.

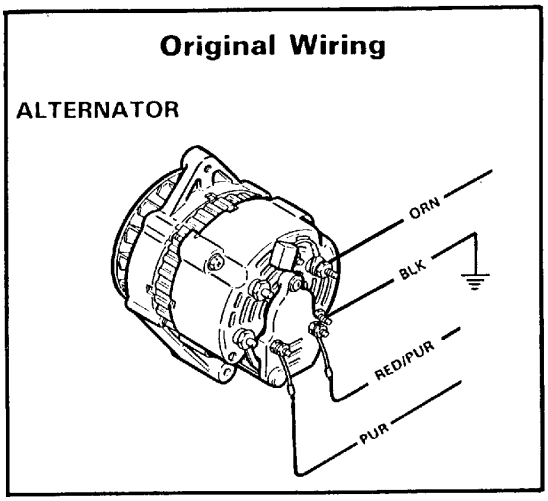
NOTE: *MerCruiser engines equipped with a 3-wire, belt driven alternator, can use a battery isolator.*

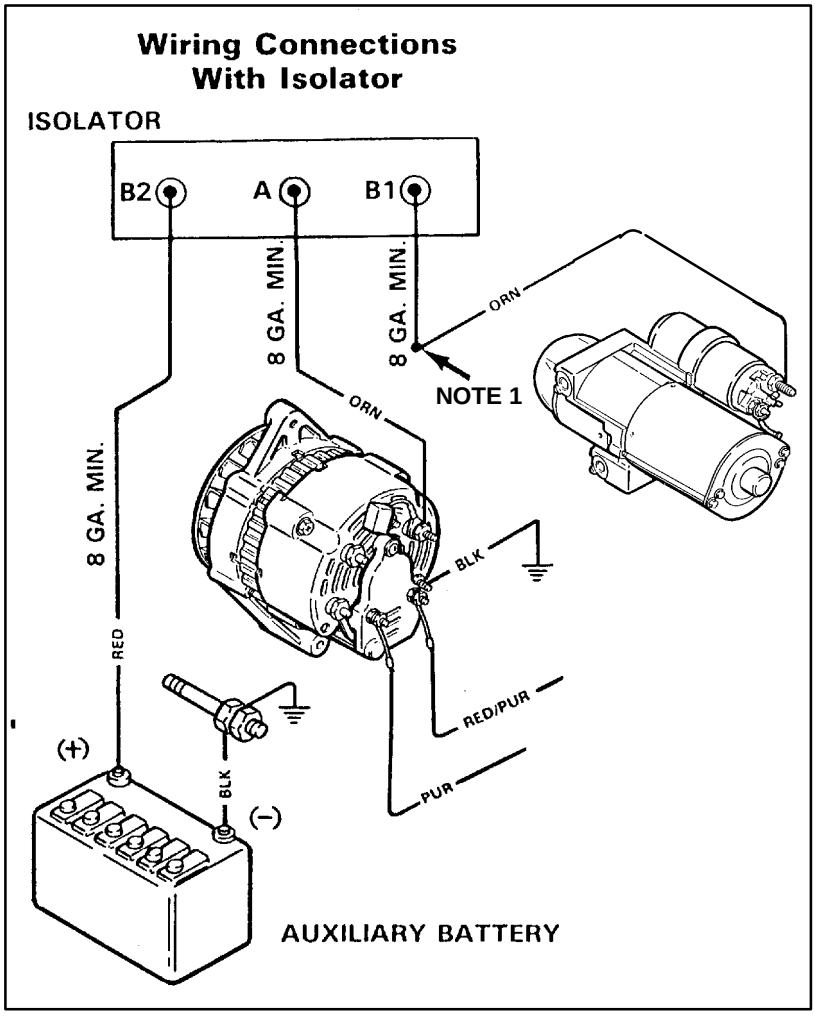
WIRING COLOR CODE ABBREVIATIONS

BLK	=	BLACK
BLU	=	BLUE
BRN	=	BROWN
GRY	=	GRAY
GRN	=	GREEN
ORN	=	ORANGE
PNK	=	PINK
PUR	=	PURPLE
RED	=	RED
TAN	=	TAN
WHT	=	WHITE
YEL	=	YELLOW
LIT	=	LIGHT
DRK	=	DARK

Battery Isolator Diagram







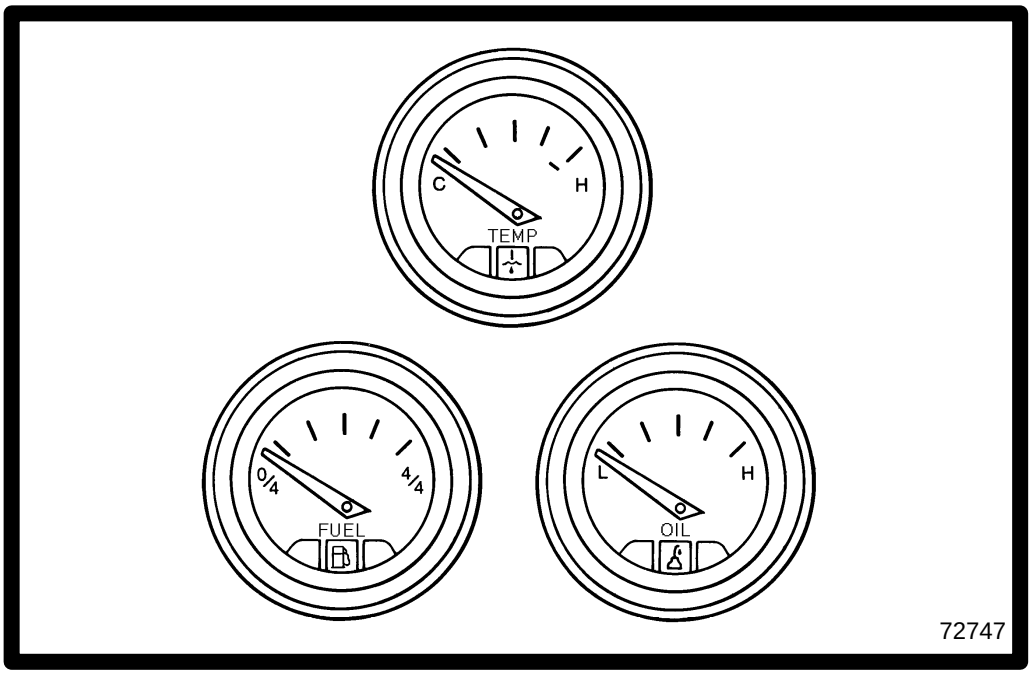
Alternator with Voltmeter Circuit (Typical Wiring Shown)

72934

NOTE 1: Disconnect ORANGE Wire From Alternator ”BATT” Terminal. Splice Sufficient Guage Wire To The ORANGE Wire And Connect As Shown.

Index

ELECTRICAL SYSTEMS



4

D

INSTRUMENTATION

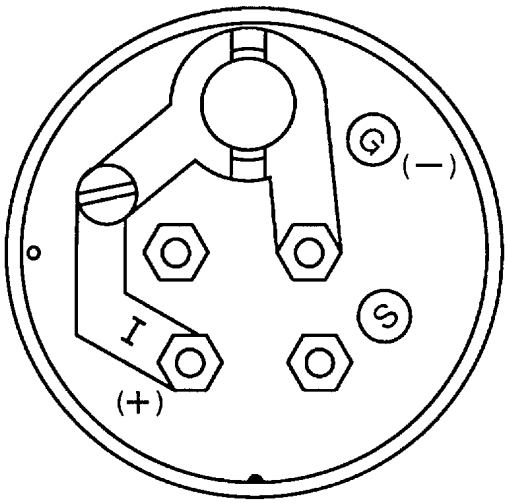
Index

Table of Contents

	Page
Identification	4D - 1
Special Information	4D - 1
Lighting Options	4D - 1
Commodore And International Series	4D - 1
QSI Series	4D - 2
Gauges	4D - 2
Oil, Fuel and Temperature	4D - 2
Testing	4D - 2
Battery Gauge	4D - 3
Testing	4D - 3
Cruiselog Meter	4D - 4
Testing	4D - 4
Vacuum Gauge	4D - 4
Testing	4D - 4
Speedometer	4D - 4
Testing	4D - 4
Calibration Chart	4D - 4
Tachometer	4D - 4
Testing	4D - 4
Gauge Replacement	4D - 4
Senders	4D - 5
Oil Pressure	4D - 5
Testing	4D - 5
Dual Station Sender Identification	4D - 5
Water Temperature Sender	4D - 5
Testing	4D - 5
Installation	4D - 6
Dual Station Sender identification	4D - 7
Fuel Tank Sender	4D - 7
Flange Type	4D - 7
Testing	4D - 7
Capsule Type	4D - 8
Testing	4D - 8
Switches	4D - 8
Ignition Key Switch	4D - 8
Testing	4D - 8
Audio Warning System	4D - 9
Buzzer	4D - 9
Testing	4D - 9
Oil Pressure Switch	4D - 10
Testing	4D - 10
Switch Identification	4D - 10
Water Temperature Switch	4D - 10
Testing	4D - 10

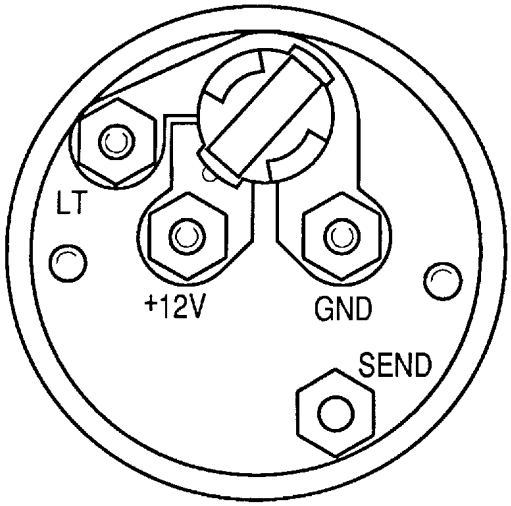
Identification

One of three distinct lines (Series) of Quicksilver gauges may be installed (if equipped with Quicksilver gauges). Aside from different gauge face appearances and styling, the back of the gauges and wiring connections are different as shown.



72746

Back of Commodore and International Series Gauge - Typical



72965

Back of QSI Series Gauge - Typical

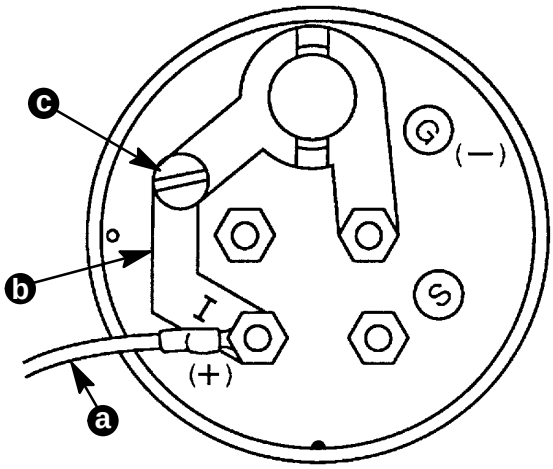
Special Information

Lighting Options

COMMODORE AND INTERNATIONAL SERIES

These gauges may be wired so that the illumination lighting is provided from the ignition switch or a separate instrumentation lighting switch.

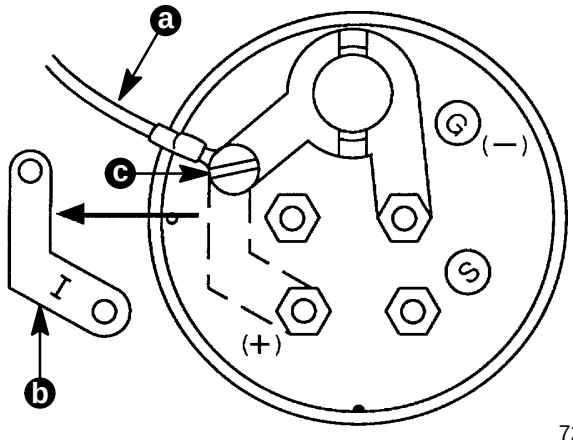
By removing contact strip “I” from between + terminal and the screw as shown following, and supplying a separate +12 V power supply to the screw connection, illumination lights can be operated independent of ignition switch.



72966

a - +12 V Power Supply from Ignition Switch
b - Contact Strip “I”
c - Screw Connection

Ignition Switch Lighting Circuit



72967

a - +12 V Power Supply from Separate Instrumentation Lighting Circuit
b - Contact Strip “I” - REMOVED
c - Screw Connection

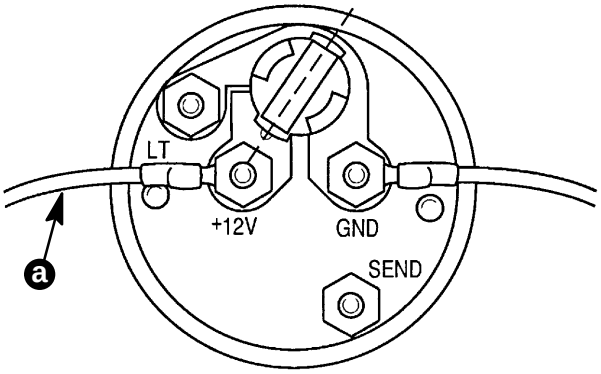
Separate Instrumentation Lighting Circuit Wiring

QSI SERIES

These gauges are equipped with optional illumination lighting. Light bulb socket can be removed and contacts can be aligned to be used with ignition switch lighting circuit +12 V or separate instrumentation lighting circuit LT.

IMPORTANT: Light socket must be removed from gauge and turned counterclockwise (facing back of gauge) when adjusting to desired setting. Turning socket while still installed in gauge could result in damage to gauge or socket.

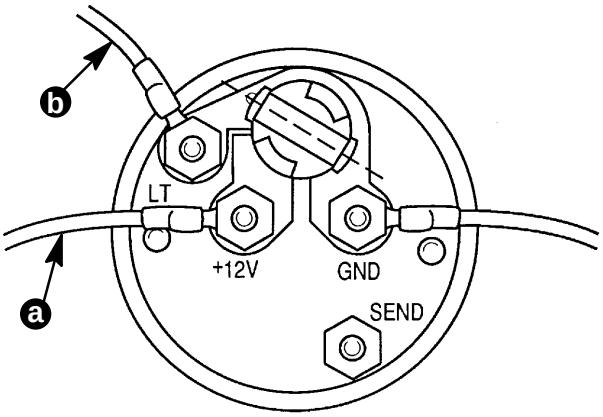
NOTE: *For different lighting effects, colored sleeves are available through the Quicksilver Accessories and can be assembled to the bulb.*



72968

a - +12 V Power Supply from Ignition Switch

Ignition Switch Lighting Circuit Position



72969

a - +12 V Power Supply from Ignition Switch
b - +12 V Power Supply from Separate Instrumentation Lighting Circuit

Separate Instrumentation Lighting Circuit Position

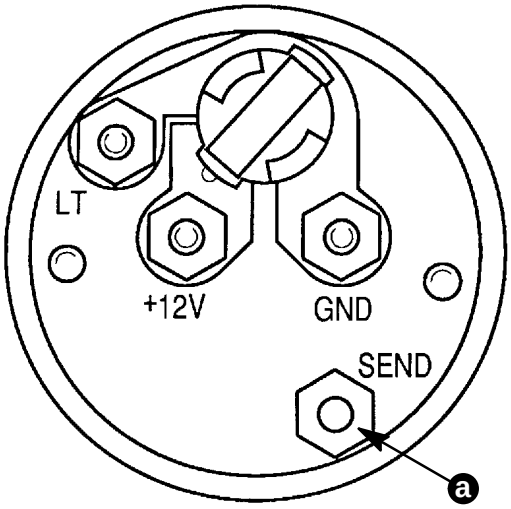
Gauges

Oil, Fuel and Temperature

IMPORTANT: If testing proves gauge to be defective, it must be replaced as there is no repair available.

TESTING

1. Turn ignition switch to OFF.
2. Remove wire from terminal S (SEND).

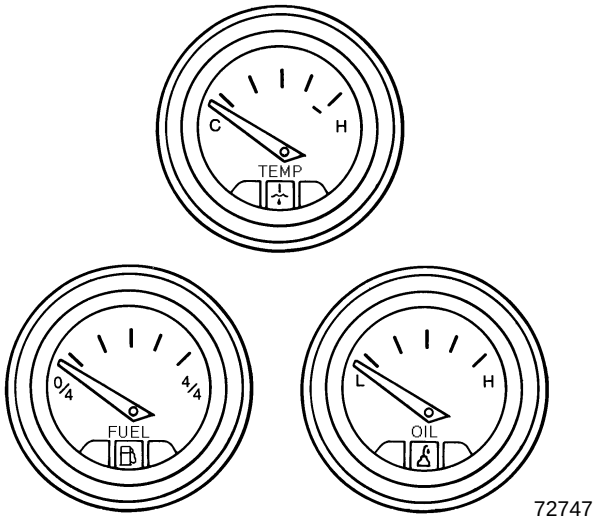


72965

a - Sender Terminal

Typical

3. Turn ignition switch to RUN. Gauge being tested must be at position A.

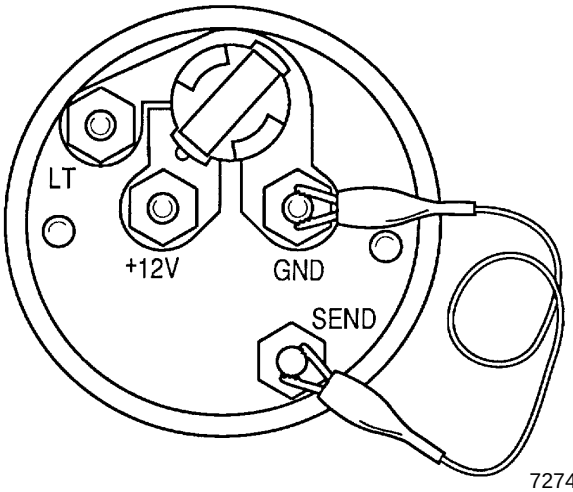


72747

Position A

Typical

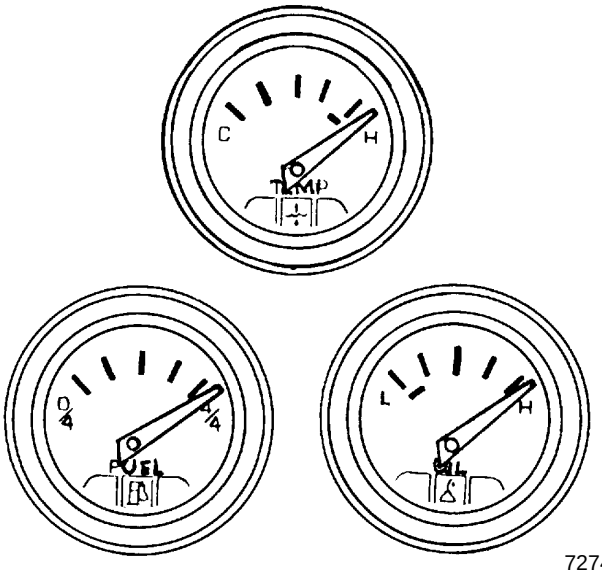
4. Turn ignition switch to OFF.
5. Connect jumper wire from terminal G (GND) to terminal S (SEND).



72748

Typical

6. Turn ignition switch to RUN.
7. Indicator needle of gauge being tested must read at position B. If not, replace gauge.



72749

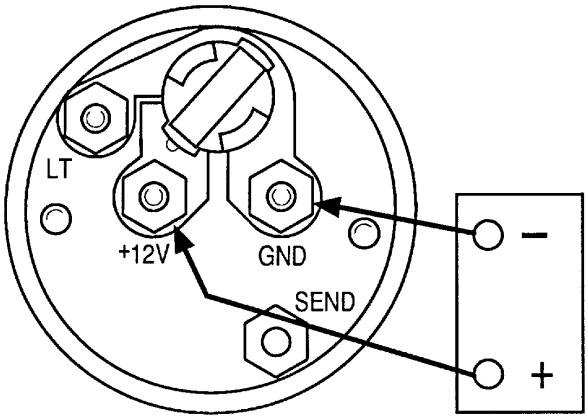
Position B

Typical

Battery Gauge

TESTING

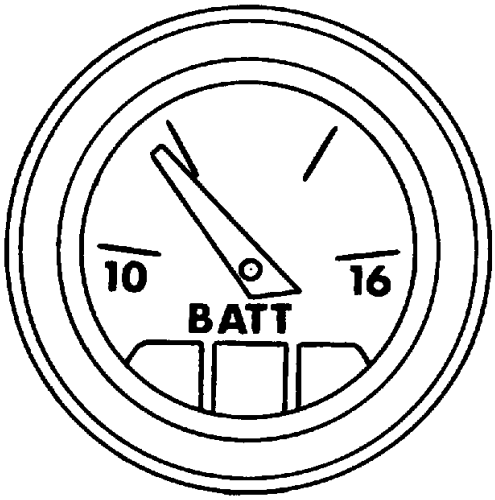
1. Remove cables from battery and fully charge battery.
2. Connect negative (–) jumper lead from battery to gauge terminal G (GND).
3. Connect positive (+) jumper lead from battery to gauge terminal I or +12 V.



72750

Typical

4. Check gauge reading; if not as shown replace gauge.



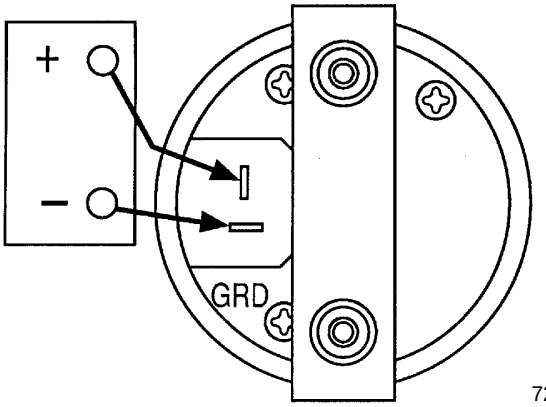
72751

Typical

Cruiselog Meter

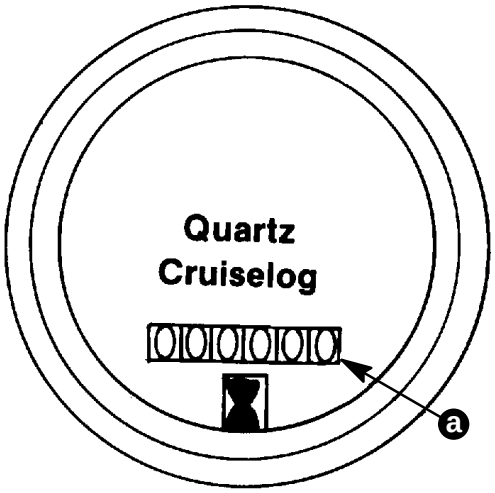
TESTING

1. Connect jumper wire from negative (–) battery terminal to negative (–) gauge terminal.
2. Connect jumper wire from positive (+) battery terminal to positive (+) gauge terminal.



72752

3. Observe gauge run indicator. If indicator is turning, gauge is operable; if not, replace gauge.



72753

a - Indicator

Vacuum Gauge

TESTING

1. Disconnect vacuum hose from engine. Connect service vacuum gauge to engine and record engine vacuum readings at idle, 1000, 2000 and 3000 RPM. Reconnect vacuum hose and compare vacuum gauge readings (at specified RPM) with service gauge readings. Readings should be within 3 inches of vacuum of each other.

IMPORTANT: Make sure that vacuum hose between gauge and engine is not leaking and that all connections are tight.

Speedometer

TESTING

IMPORTANT: When testing speedometer gauge for accuracy, the air supply used for the test must be regulated to the specified air pressure. Do not apply excessive air pressure to speedometer gauge.

1. Apply air pressure directly to speedometer gauge (specified in chart) and note gauge reading. Light tapping of pressure gauge is required during accuracy check.
2. If gauge readings are not within specifications, gauge is defective

CALIBRATION CHART

Air Pressure Gauge PSI	Speedometer Gauge MPH (km/Hr)
5.3	20 ± 1 (32 ± 1.6)
27.8	45 ± 1 (72 ± 1.6)

Tachometer

TESTING

1. Connect a service tachometer to engine and compare readings.
2. Replace if not within specifications.

Tachometer Type	Allowable Range
6000 RPM	± 150 RPM
8000 RPM	± 200 RPM

Gauge Replacement

1. Disconnect battery cables from battery.
2. Remove wires from back of gauge.
3. Remove hoses (vacuum, speedometer gauge).
4. Disconnect light socket.
5. Remove holding strap and remove gauge.
6. Position gauge assembly in appropriate mounting hole.
7. Install holding strap and nuts. Tighten nuts evenly and securely.

Index

IMPORTANT: Do not distort case or bracket by over-tightening.

8. Connect ground (BLACK) wire to ground terminal, if gauge is not mounted in metal panel.
9. Connect other wires to gauge as shown in Section 4E.
10. Connect hoses (vacuum, speedometer gauges).
11. Install gauge light socket.
12. Coat all terminals with Quicksilver Liquid Neoprene.
13. Reconnect battery cables to battery.

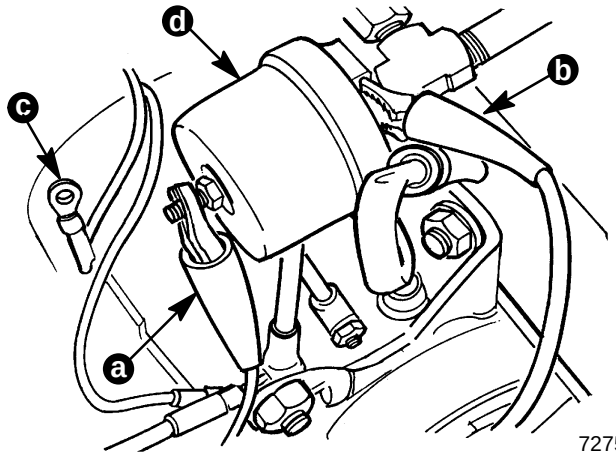
Senders

Oil Pressure

TESTING

IMPORTANT: Use following test procedure for checking accuracy of oil pressure sender only. If oil pressure gauge indicates zero oil pressure, refer to SECTION 4C - "Troubleshooting."

1. Remove wire from sender terminal.
2. Connect ohmmeter between sender terminal and sender case. Check ohms reading without engine running (zero pressure), then check reading with engine running. Compare oil pressure and ohms readings as shown in following chart:



72754

a - Positive Lead
b - Negative Lead
c - Wire Removed
d - Oil Pressure Sender

Oil Pressure (PSI)	Ohms Reading	
	Single	Dual
0	227-257	113.5-128.5
20	142-162.5	71-81.3
40	91.7-113.6	45.9-56.8
80	9-49	11-24.5

DUAL STATION SENDER IDENTIFICATION

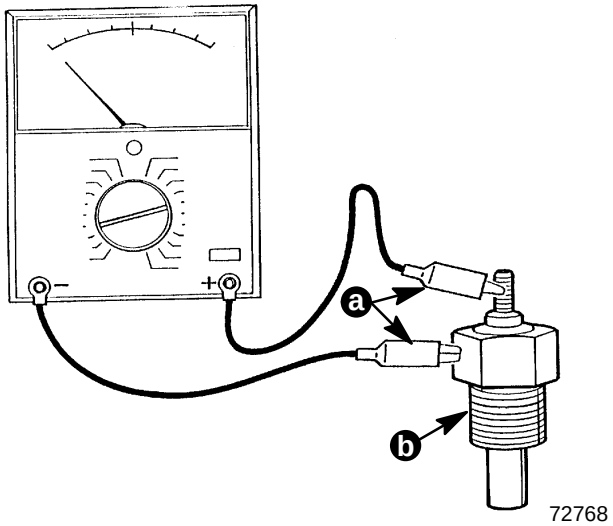
Sender will have 3353-AM stamped on hex of sender.

Water Temperature Sender

There is no accurate test that can be done without special equipment. Install new sender.

TESTING

1. Connect an ohmmeter between temperature sender terminal (+) and hex (case) for ground (–) as shown.



72768

a - Ohmmeter Leads
b - Water Temperature Sender

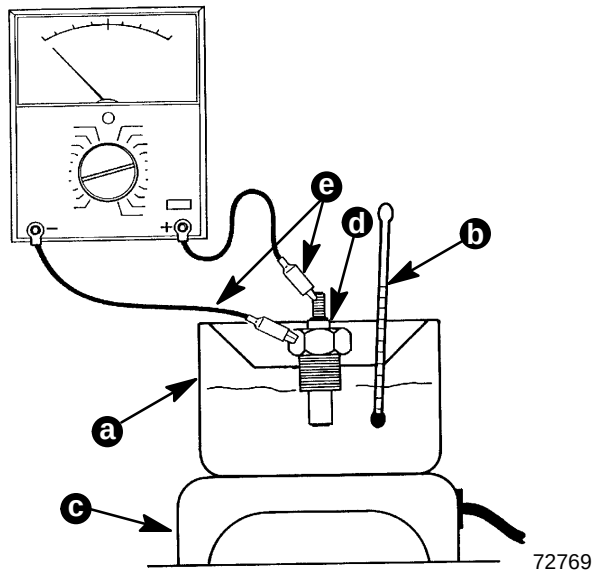
⚠ WARNING

The following test involves the use of intense heat. Failure to follow appropriate procedures or warnings can cause burns which can result in severe personal injury. While performing the following test, observe these general precautions:

- **Wear personal protective clothing such as rubber gloves, a non-flammable apron, and eye protection - preferably full face shield or safety glasses.**
- **The appropriate heat source should only be electric. Heat source should be operated by a qualified person. Be sure to follow all instructions of the manufacturer of the heat source. The heat source should be checked each time it is used to be sure it is functioning properly.**
- **The thermometer used in the test should be a high-temperature thermometer with a maximum reading of at least 300°F (150°C). Under no circumstances should the operator allow temperatures to exceed test specifications.**
- **Perform test only in a well ventilated area.**
- **Use a suitable container, such as metal, to hold the water. Avoid use of glass containers unless the operator first confirms for himself/herself that the glass container is an appropriate high-temperature vessel.**
- **Because the components will reach high temperatures DO NOT handle materials or components until COMPLETELY cooled.**

2. Follow these instructions:
   a. With ohmmeter connected as outlined and using suitable container, thermometer and heat source, suspend sender with tip in water.
   b. Heat water and observe thermometer.
   c. As temperature rises ohmmeter readings must be within the ranges specified for each temperature (see chart below).
   d. Turn heat source off. Allow water and components to cool.

NOTE: *While water cools you may recheck ohmmeter readings.*



a - Suitable Container
b - Thermometer
c - Heat Source
d - Water Temperature Sender
e - Ohmmeter Leads

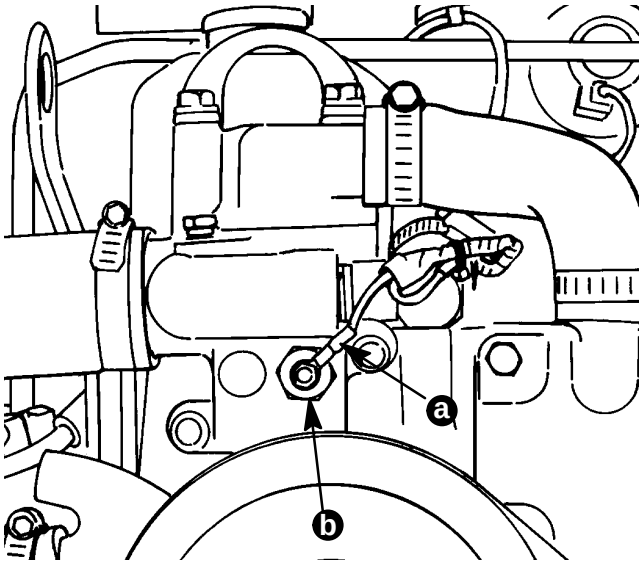
Water Temperature	Ohms Reading
140°F (60°C)	121-147
194°F (90°C)	47-55
212°F (100°C)	36-41

3. Replace sender if ohmmeter readings are other than as shown for each temperature.

INSTALLATION

1. Apply Loctite Pipe Sealant with Teflon to threads of temperature sender.
2. Install sender in thermostat housing and tighten securely.

3. Connect TAN wire and coat with liquid neoprene.



a - TAN Wire
b - Water Temperature Sender

4. Refill closed cooling system with approved coolant as outlined in Section 6B.

DUAL STATION SENDER IDENTIFICATION

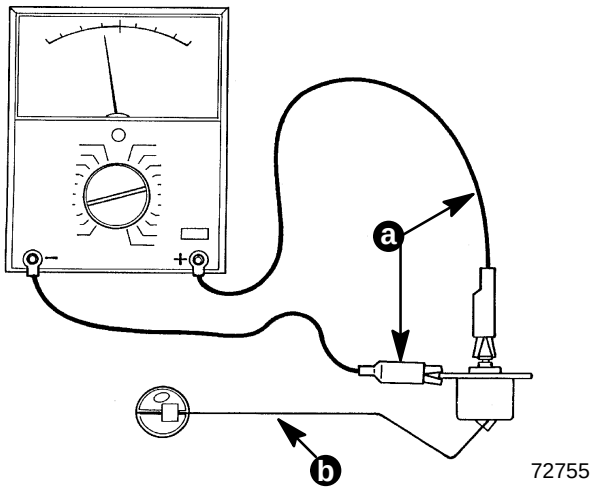
Sender will have 362-BC stamped on hex.

Fuel Tank Sender

Flange Type

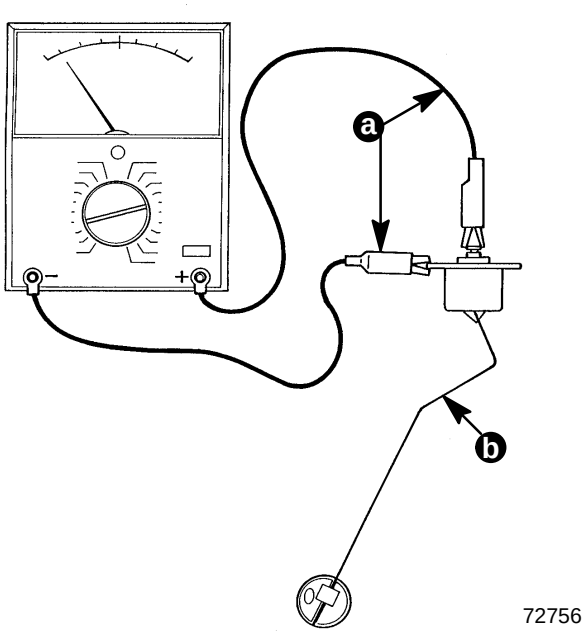
TESTING

1. Disconnect wire from terminal on sending unit and ground wire from sending unit mounting screw.
2. Remove sending unit from fuel tank.
3. Connect ohmmeter between sending unit terminal and sending unit housing.
4. With float arm in FULL position (arm horizontal), ohmmeter should read 30 ohms (± 5 ohms).



a - Ohmmeter Leads
b - Vertical Float Arm

5. With float arm in EMPTY position (arm vertical) meter should read 240 ohms (± 5 ohms). Sender is defective if not within specifications.

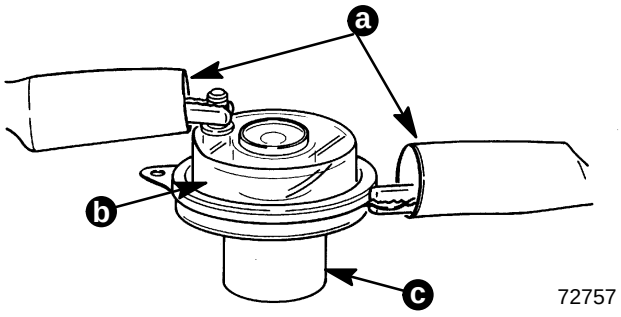


a - Ohmmeter Leads
b - Vertical Float Arm

Capsule Type

TESTING

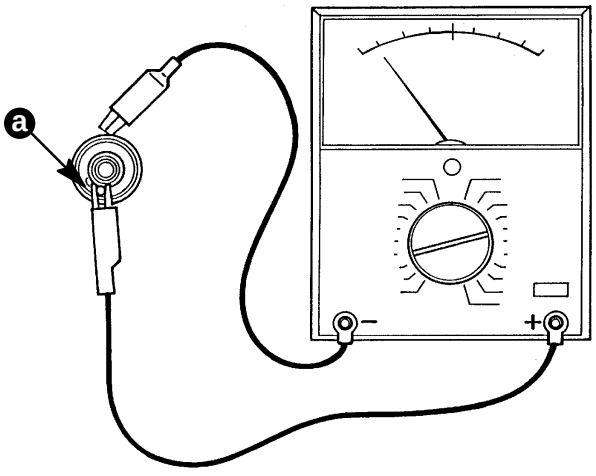
1. Disconnect wire from terminal on fuel tank capsule.
2. Remove two screws and remove capsule assembly.
3. Place a magnet under fuel capsule.
4. Connect ohmmeter between fuel capsule terminal and metal portion of capsule housing.



72757

a - Ohmmeter Leads
b - Capsule Assembly
c - Magnet

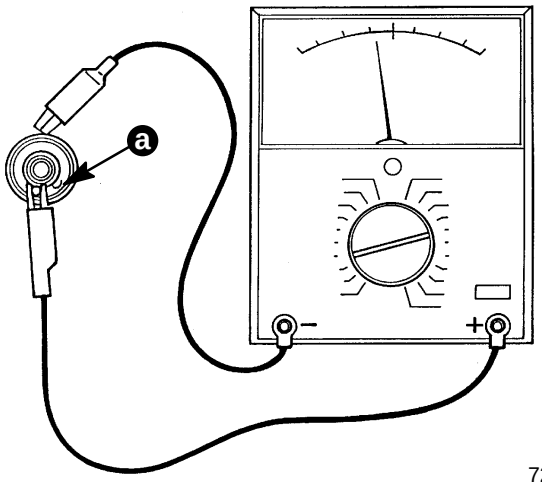
5. Turn magnet counterclockwise until fuel capsule indicator reads EMPTY. Ohmmeter should read 240 ohms (± 5 ohms).



72758

a - Capsule Reading Empty

6. Turn magnet clockwise until fuel capsule indicator reads FULL. Ohmmeter should read 30 ohms (± 5 ohms). Fuel capsule is defective if not within specifications.



72759

a - Capsule Reading Full

Switches

Ignition Key Switch

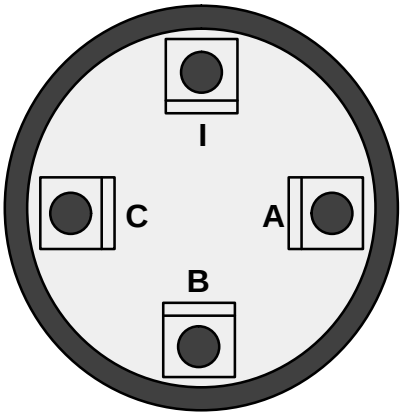
TESTING

⚠ WARNING

Disconnect battery cables from battery before testing ignition key switch with wires still connected to switch.

1. Before testing key switch, check all fuses and/or circuit breakers in electrical circuit which could prevent operation of starter.
2. With key switch in OFF position, there should be no continuity between switch terminals.
3. With key switch in RUN position, continuity will exist between switch terminals B to A and B to I. There should be no continuity between terminal C and any other terminals.

4. With key switch in START, continuity will exist between terminals B to A, B to I and B to C.
5. If ignition key switch tests bad, unsolder wire connections and remove switch. Test switch again, as in Steps 2-5, preceding. If switch tests good, wiring in harness is bad. There should be no continuity between any harness wires with key switch removed.



Switch Terminal Identification

Audio Warning System

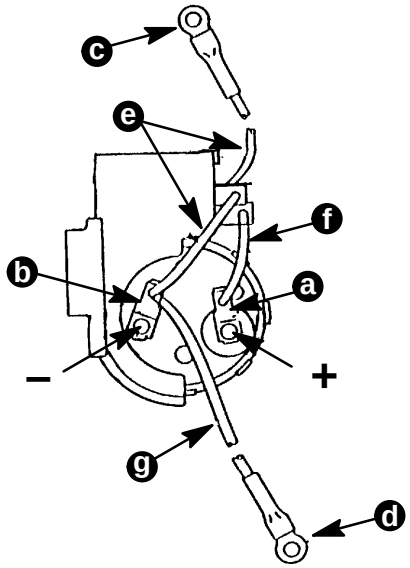
Buzzer

⚠WARNING

The following test involves the use of electricity. Failure to follow appropriate procedures can cause burns or shock which can result in severe personal injury or death.

TESTING

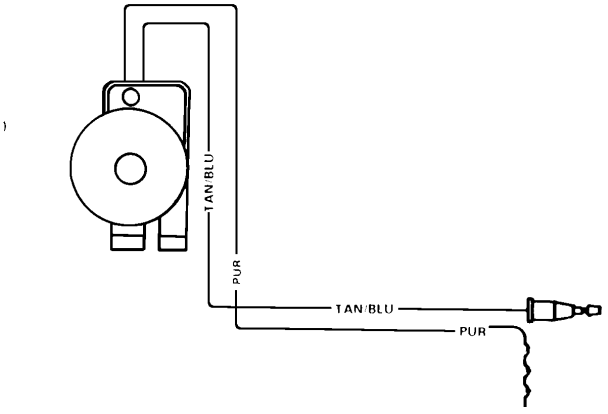
1. Turn key to RUN position (engine off).
2. Wait 7 to 14 seconds for horn to sound.
3. If horn does not sound:
   a. Connect jumper wires as shown.
   b. If horn does not sound, replace it.
4. If horn worked in Step 3:
   a. Connect jumper wires as shown.
   b. Repeat Step 2.
   c. If horn sounds, problem is in TAN/BLUE wire back to engine or switches on engine.



72612

Earlier Style With Timer

a - Jumper Wire to 12 Volt (+) —
b - Jumper Wire to Ground (–) — Step 3
c - Jumper Wire to 12 Volt (+) —
d - Jumper Wire to Ground (–) — Step 3
e - PURPLE Wire
f - RED Wire
g - TAN/BLUE Wire



74046

Later Style Buzzer

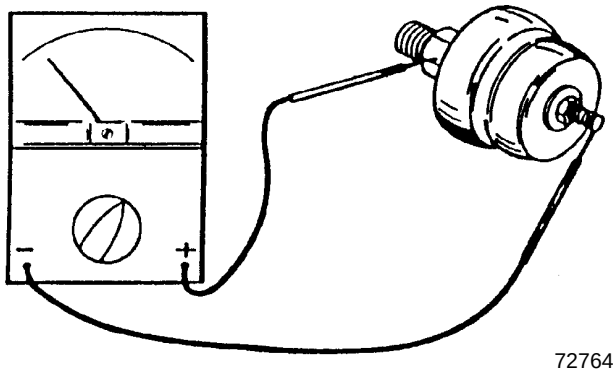
Index

Oil Pressure Switch

Refer to Section 4E for switch locations. Switch is normally closed.

TESTING

1. Remove wire from sender terminal.
2. Connect continuity meter between sender terminal and sender hex. (Sender shown removed for clarity.)



72764

3. With engine not running, meter should indicate full continuity.
4. Start engine. With engine running and engine oil pressure above 6 PSI (41 kPa), meter should indicate NO continuity.

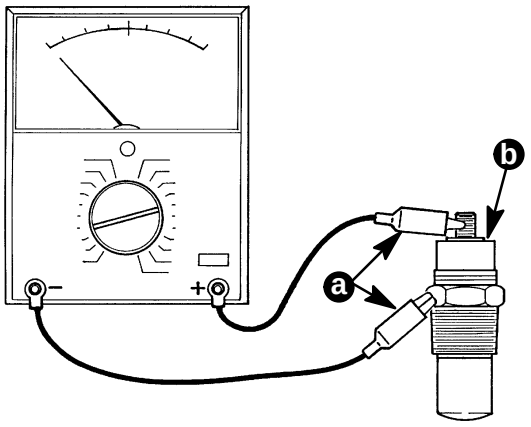
SWITCH IDENTIFICATION

Switch has 364-AF stamped on hex of sender.

Water Temperature Switch

TESTING

1. Connect an ohmmeter between water temperature switch terminal (+) and hex (case) for ground (–) as shown.



72765

a - Ohmmeter Leads
b - Water Temperature Switch

2. Switch should read no continuity.

⚠ WARNING

The following test involves the use of intense heat. Failure to follow appropriate procedures or warnings can cause burns which can result in severe personal injury. While performing the following test, observe these general precautions:

- **Wear personal protective clothing such as rubber gloves, a non-flammable apron, and eye protection - preferably full face shield or safety glasses.**
- **The appropriate heat source should only be electric. Heat source should be operated by a qualified person. Be sure to follow all instructions of the manufacturer of the heat source. The heat source should be checked each time it is used to be sure it is functioning properly.**
- **The thermometer used in the test should be a high- temperature thermometer with a maximum reading of at least 300°F (150°C). Under no circumstances should the operator allow temperatures to exceed test specifications.**
- **Perform test only in a well ventilated area.**
- **Use a suitable container, such as metal, to hold the sand. Avoid use of glass containers unless the operator first confirms for himself/herself that the glass container is an appropriate high-temperature vessel.**
- **Because the components will reach high temperatures DO NOT handle materials or components until COMPLETELY cooled.**

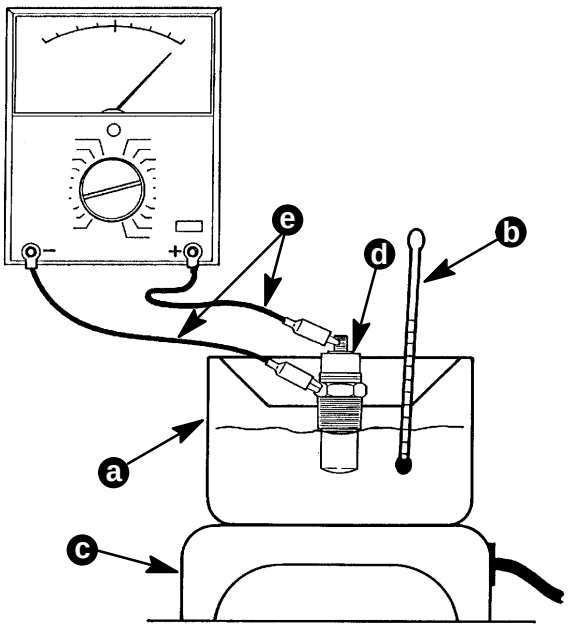
⚠ WARNING

Use only clean, dry sand such as used for general sandblasting purposes. Use of sand containing contaminants could result in hazards such as fire, short circuiting, hot-spots, or other hazards.

3. Follow these instructions:
   a. With an ohmmeter connected as outlined and using suitable container, thermometer and heat source, suspend sender with tip in sand.

Index

b. Heat sand and observe temperature on thermometer.



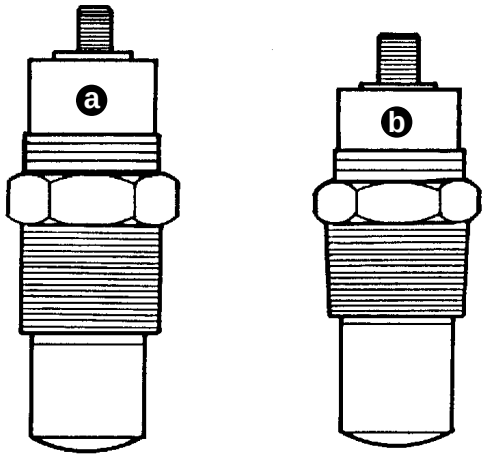
72766

a - Suitable Container
b - Thermometer
c - Heat Source
d - Water Temperature Switch
e - Ohmmeter Leads

c. As temperature rises, switch will close and ohmmeter will indicate continuity. Refer to chart below for specifications.

48952 Switch	
Opens	150-170°F (60-77°C)
Closes	190-200°F (88-93°C)

87-86080 Switch	
Opens	175-195°F (79-91°C)
Closes	215-225°F (102-107°C)



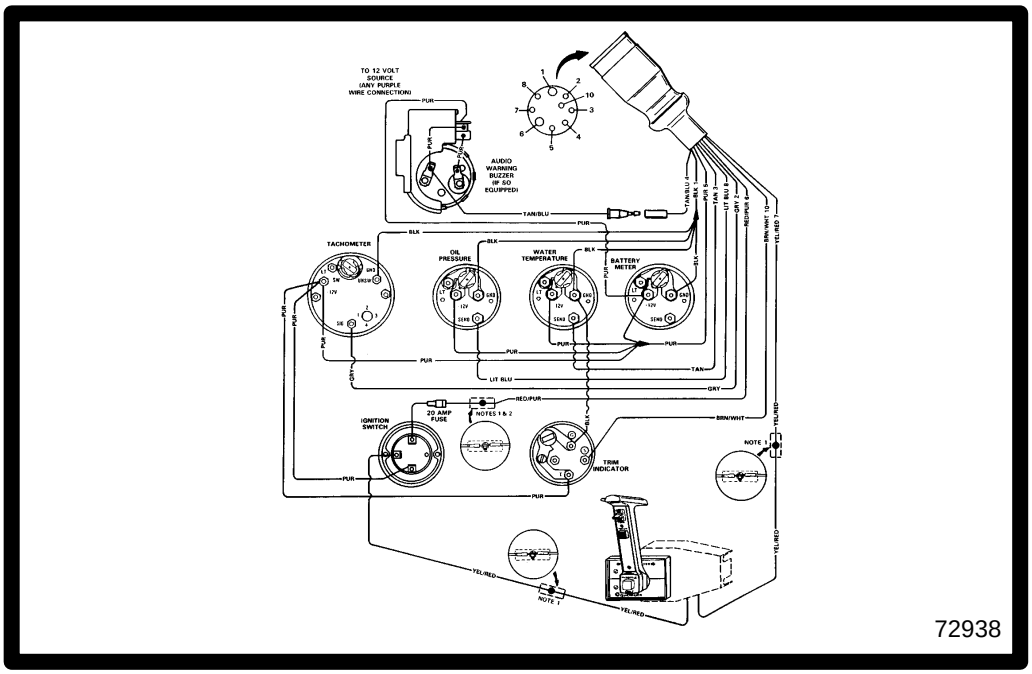
72767

a - 48952 Switch with Red Mylar Sleeve
b - 87-86080 Switch with Black Mylar Sleeve

Switch Identification

4. Turn heat source off. Allow sand to cool. Note thermometer reading to ensure switch “opens” up at specified temperature.
5. Replace switch if switch fails to either open or close within the specified temperatures.

ELECTRICAL SYSTEMS



4

E

WIRING DIAGRAMS

Index

Table of Contents

Page

Wiring Colors for MerCruiser . . . . . 4E - 1
Wiring Diagrams . . . . . 4E - 2
3.0L Engine Wiring Diagram (Breaker Points Ignition) . . . . . 4E - 2
3.0L/3.0LX Engine Wiring Diagram (DDIS Ignition) . . . . . 4E - 3
3.0L/3.0LX Engine Wiring Diagram (EST Ignition) . . . . . 4E - 4
Instrumentation Wiring Diagram (Battery Meter Circuit) . . . . . 4E - 5
Instrument Wiring Harness . . . . . 4E - 7
Breaker Point Ignition - Dual Station Using A Neutral Safety Switch In Only One Remote Control . . . . . 4E - 7
EST and DDIS ignition - Dual Station Using A Neutral Safety Switch In Only One Remote Control . . . . . 4E - 8

Page

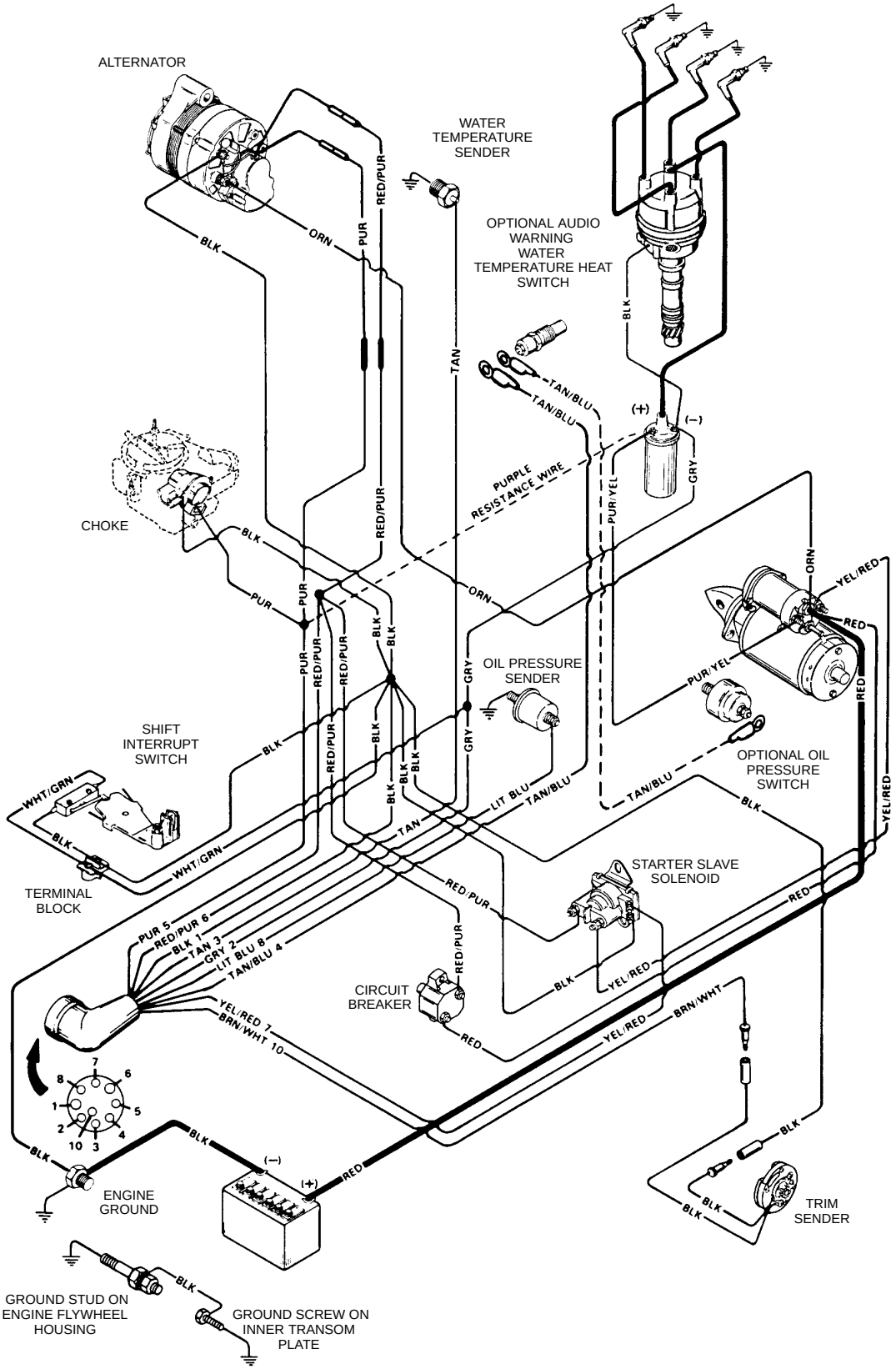
Breaker Point Ignition - Dual Station Using A Neutral Safety Switch In Both Remote Controls . . . . . 4E - 9
EST and DDIS Ignition - Dual Station Using A Neutral Safety Switch In Both Remote Controls . . . . . 4E - 10
Battery Meter Gauge . . . . . 4E - 11
Cruiselog . . . . . 4E - 11
Fuel Gauge and Sender . . . . . 4E - 11
Audio Warning System . . . . . 4E - 12
Water Temperature Gauge . . . . . 4E - 12
Oil Pressure Gauge . . . . . 4E - 12
Clock . . . . . 4E - 12

Wiring Colors for MerCruiser

BIA COLOR CODE AND ABBREVIATIONS	WHERE USED
BLACK (BLK)	All Grounds
BROWN (BRN)	Reference Electrode-MerCathode
ORANGE (ORN)	Anode Electrode-MerCathode
LIGHT BLUE/WHITE (LIT BLU / WHT)	Trim- ”Up” Switch
GRAY (GRY)	Tachometer Signal
GREEN/WHITE (GRN / WHT)	Trim -”Down” Switch
TAN (TAN)	Water Temperature Sender to Gauge
LIGHT BLUE (LIT BLU)	Oil Pressure Sender to Gauge
PINK (PNK)	Fuel Gauge Sender to Gauge
BROWN/WHITE (BRN / WHT)	Trim Sender to Trim Gauge
PURPLE/WHITE (PUR / WHT)	Trim-”Trailer” Switch
RED (RED)	Unprotected Wires from Battery
RED/PURPLE (RED / PUR)	Protected (Fused) Wires from Battery
RED/PURPLE (RED / PUR)	Protected (+12V) to Trim Panel
ORANGE (ORN)	Alternator Output
PURPLE/YELLOW (PUR / YEL)	Ballast Bypass
PURPLE (PUR)	Ignition Switch (+12 V)
YELLOW/RED (YEL / RED)	Starter Switch to Starter Solenoid to Neutral Start Switch

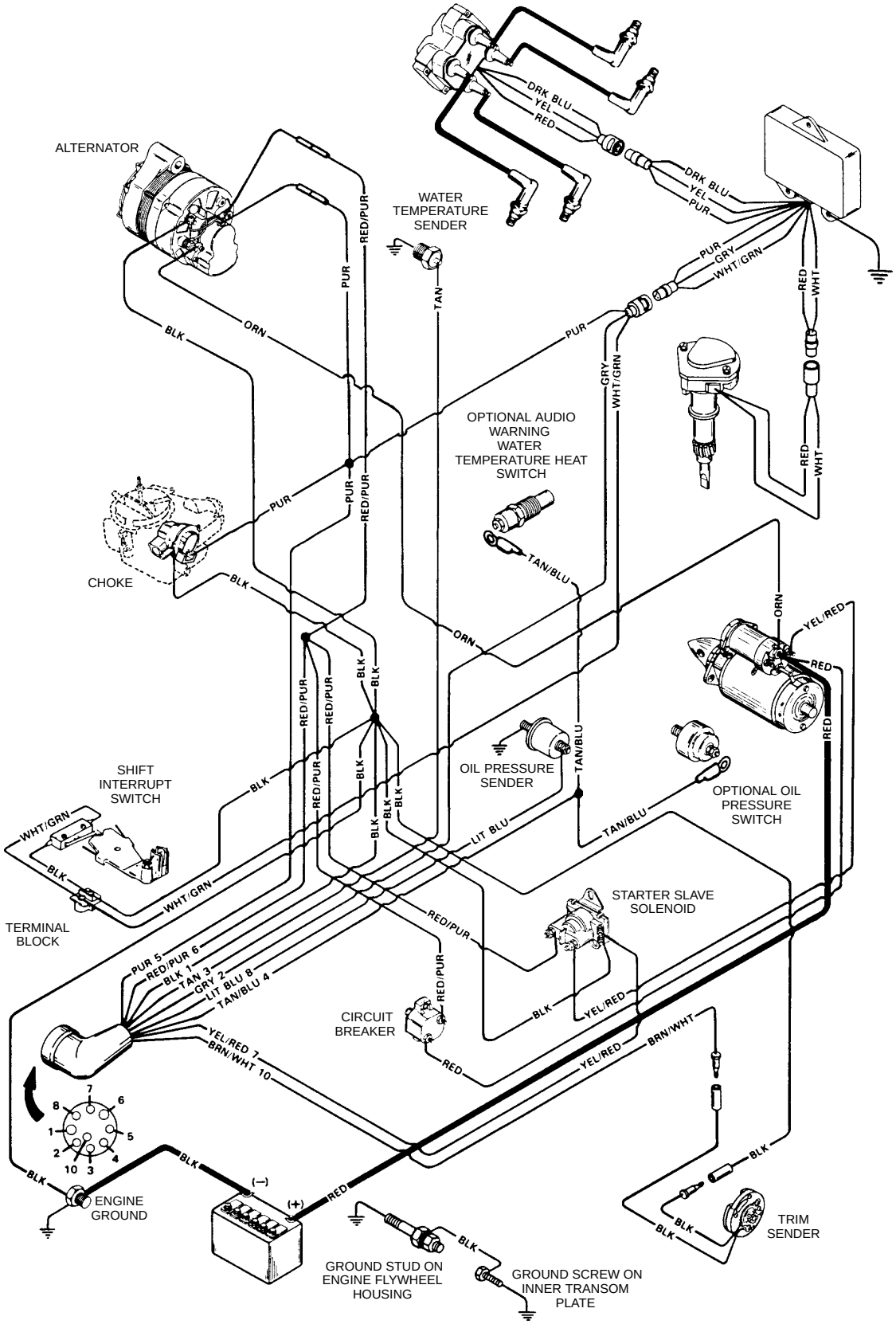
Wiring Diagrams

3.0L Engine Wiring Diagram (Breaker Points Ignition)

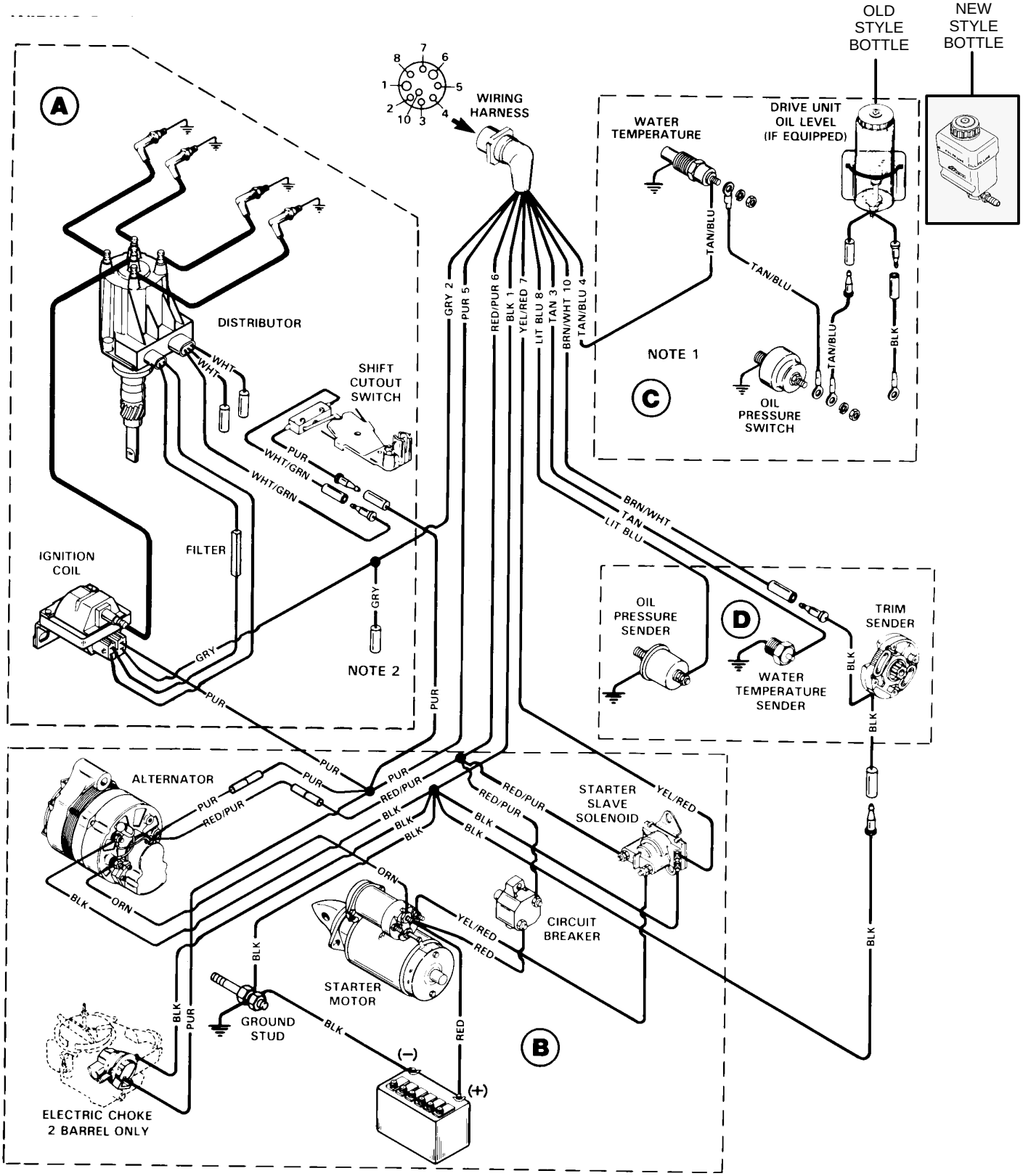


50726

3.0L/3.0LX Engine Wiring Diagram (DDIS Ignition)



3.0L/3.0LX Engine Wiring Diagram (EST Ignition)



NOTE 1: Audio Warning System Standard On 3.0LX Models

NOTE 2: Gray lead for use with service tachometer.

A - Ignition Components
B - Starting , Charging and Choke Components
C - Audio Warning System Components
D - Instrumentation Components

Index

Instrumentation Wiring Diagram (Battery Meter Circuit)

NOTE 1: Connect wires together with screw and hex nut. Tighten securely and coat with Liquid Neoprene to help control corrosion: when dry, slide neoprene sleeve over connection.

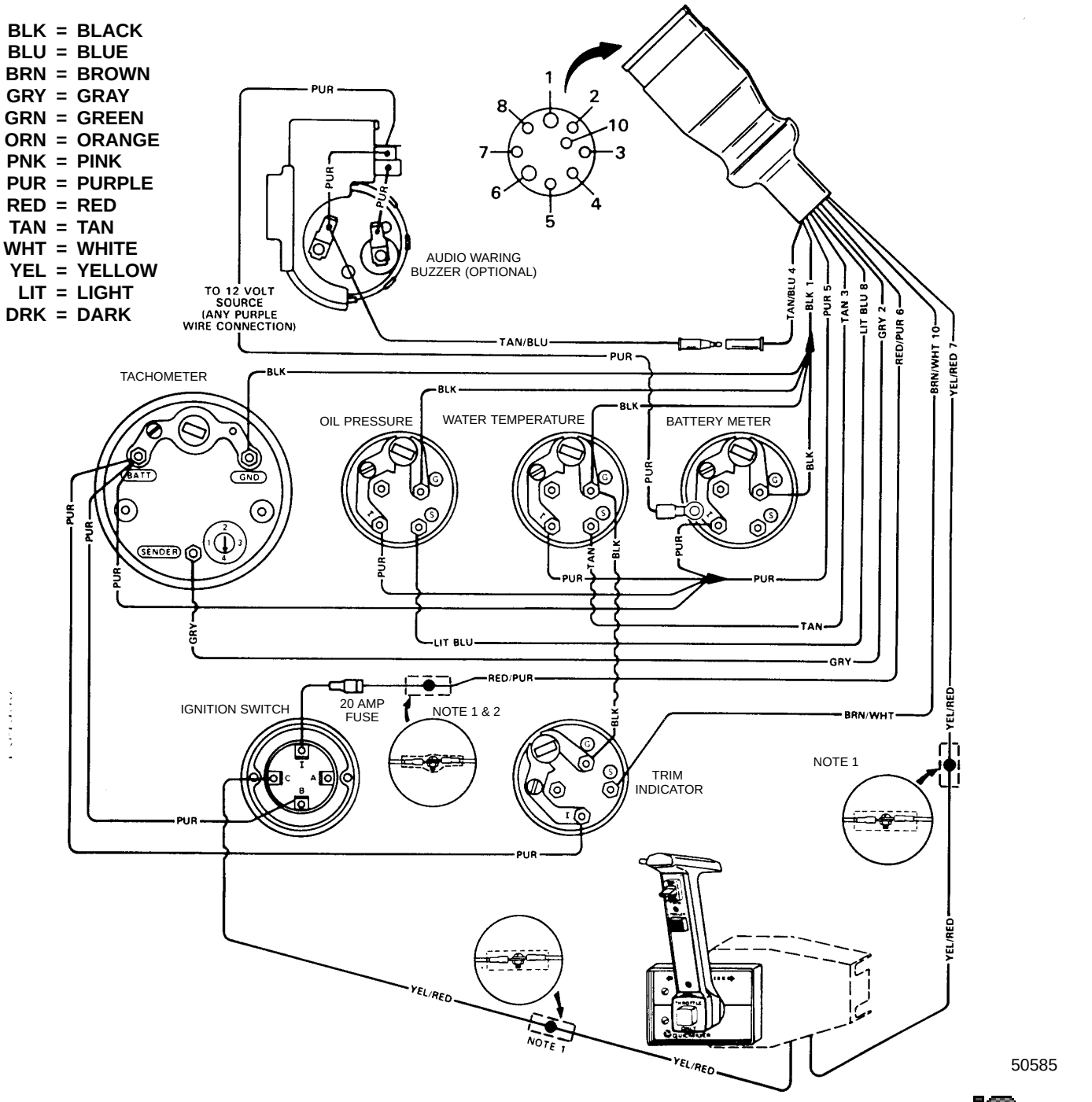
NOTE 2: Power for a fused accessory panel may be taken from this connection. Load must not exceed 40 amps. Panel ground wire must be connected to instrument terminal that has an 8-gauge BLACK (ground) har ness wire connected to it.

NOTE 3: Audio warning is standard 3.0LX models and optional on 3.0L.

⚠CAUTION

Audio warning buzzer is not external ignition proof, therefore, <u>DO NOT</u> mount buzzer in engine or fuel tank compartments.

BLK = BLACK
BLU = BLUE
BRN = BROWN
GRY = GRAY
GRN = GREEN
ORN = ORANGE
PNK = PINK
PUR = PURPLE
RED = RED
TAN = TAN
WHT = WHITE
YEL = YELLOW
LIT = LIGHT
DRK = DARK



50585

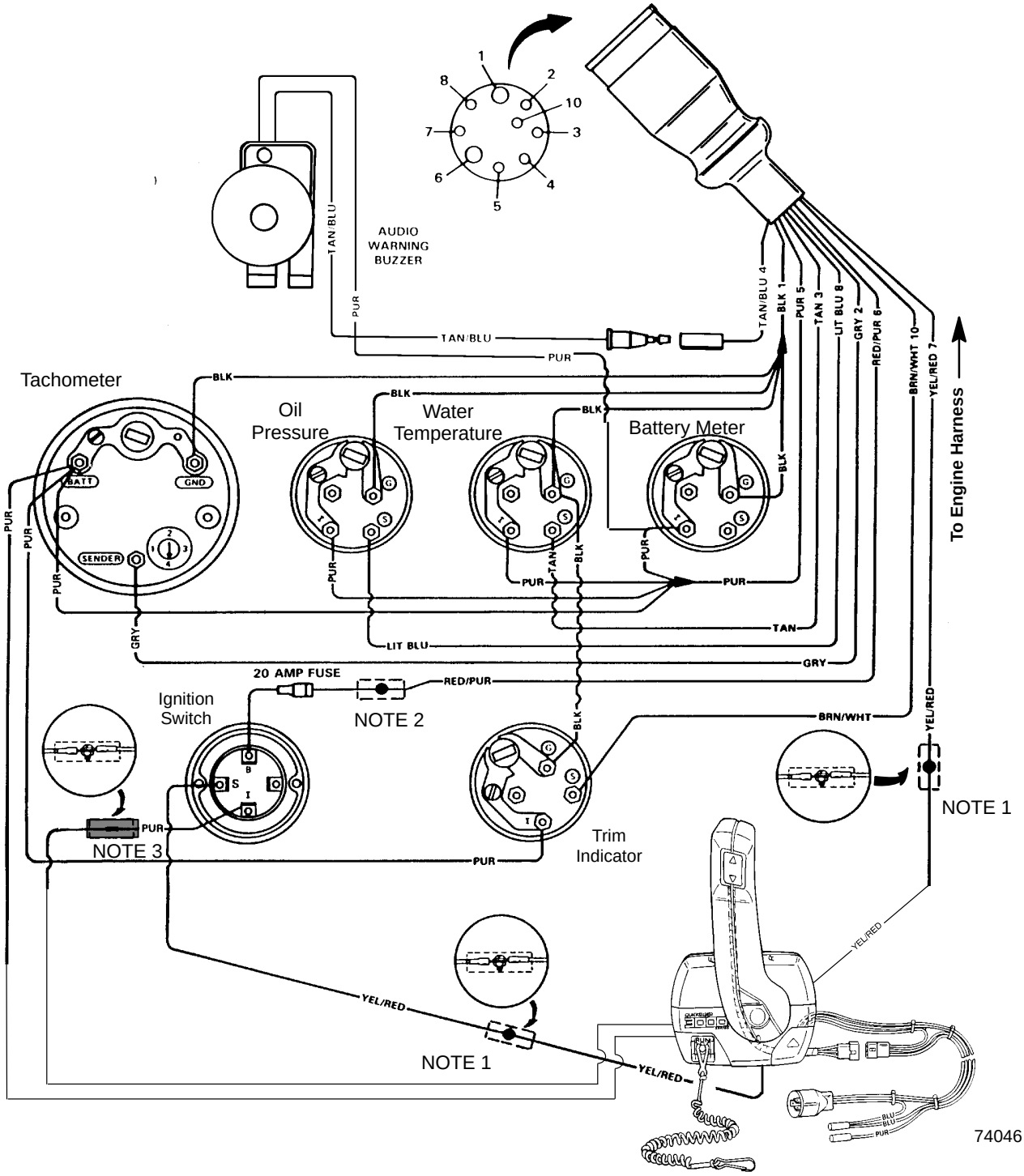
Earlier Style Audio Warning Buzzer

Index

NOTE 1: Connect wires together with screw and hex nut. Tighten securely and coat with Liquid Neoprene to help control corrosion: when dry, slide neoprene sleeve over connection.

NOTE 2: Power for a fused accessory panel may be taken from this connection. Load must not exceed 40 amps. Panel ground wire must be connected to instrument terminal that has an 8-gauge BLACK (ground) harness wire connected to it.

NOTE 3: Audio warning is standard 3.0LX models and optional on 3.0L.

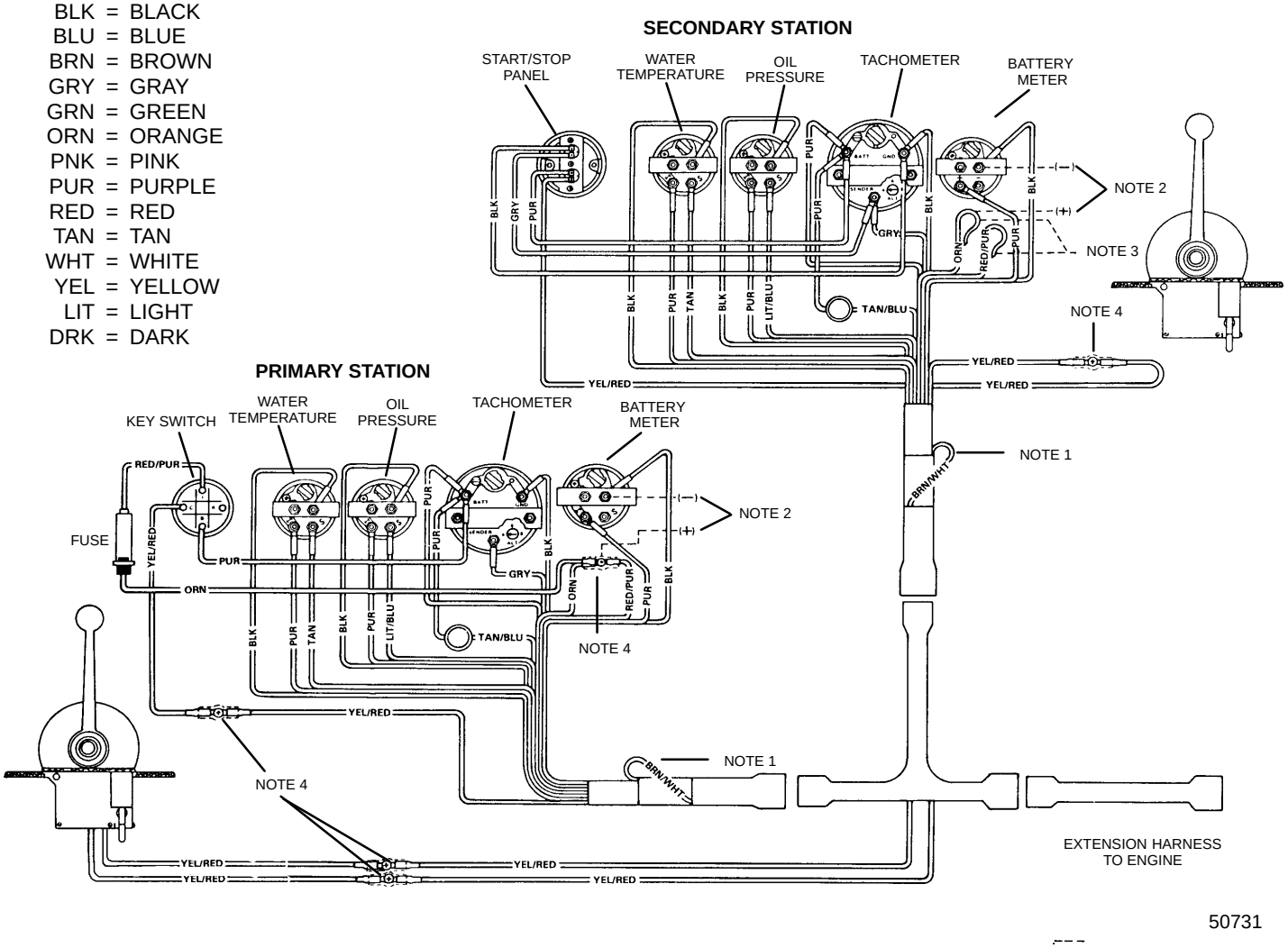


Later Style Audio Warning Buzzer

Instrument Wiring Harness (Dual Station)

BREAKER POINT IGNITION - DUAL STATION USING A NEUTRAL SAFETY SWITCH IN ONLY ONE REMOTE CONTROL

BLK = BLACK
BLU = BLUE
BRN = BROWN
GRY = GRAY
GRN = GREEN
ORN = ORANGE
PNK = PINK
PUR = PURPLE
RED = RED
TAN = TAN
WHT = WHITE
YEL = YELLOW
LIT = LIGHT
DRK = DARK



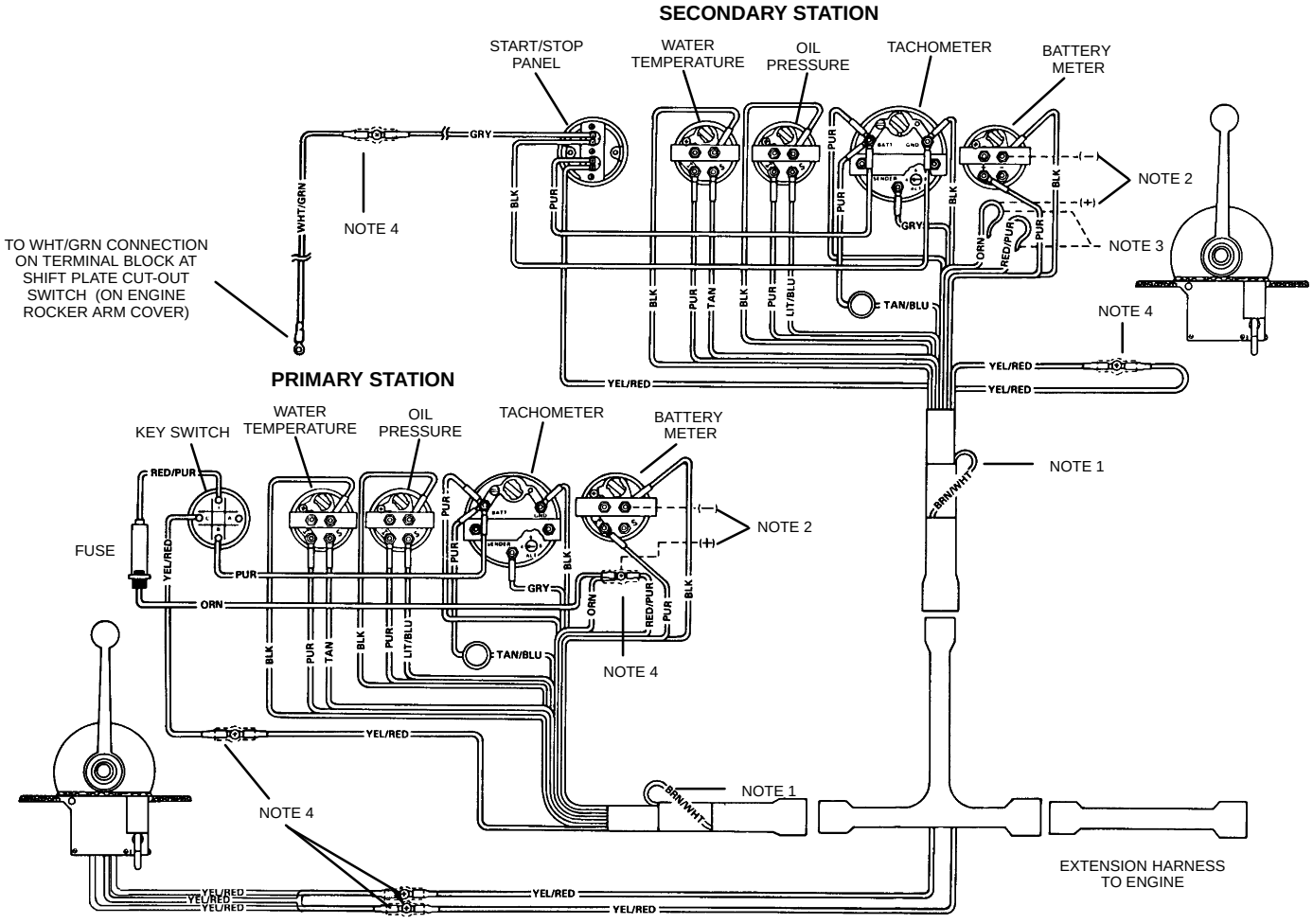
NOTE 1: BROWN/WHITE wire is taped back at instrument end. If installing on boat that is equipped with MerCruiser Stern Drive, BROWN/WHITE wire is connected to the trim sender terminal block. Also can be used for an accessory (limit 5 amps).

NOTE 2: An accessory fuse panel may be connected at this location. The combined current draw of the primary station and secondary station MUST NOT exceed 5 amps.

NOTE 3: Tape back and insulate with at least four layers of electrical tape.

NOTE 4: Connect wires together with screw and hex nut. Tighten securely and coat with Liquid Neoprene to help control corrosion; when dry, slide neoprene sleeve over connection.

EST AND DDIS IGNITION - DUAL STATION USING A NEUTRAL SAFETY SWITCH IN ONLY ONE REMOTE CONTROL



50730

NOTE 1: BROWN/WHITE wire is taped back at instrument end. If installing on boat that is equipped with MerCruiser Stern Drive, BROWN/WHITE wire is connected to the trim sender terminal block. Also can be used for an accessory (limit 5 amps).

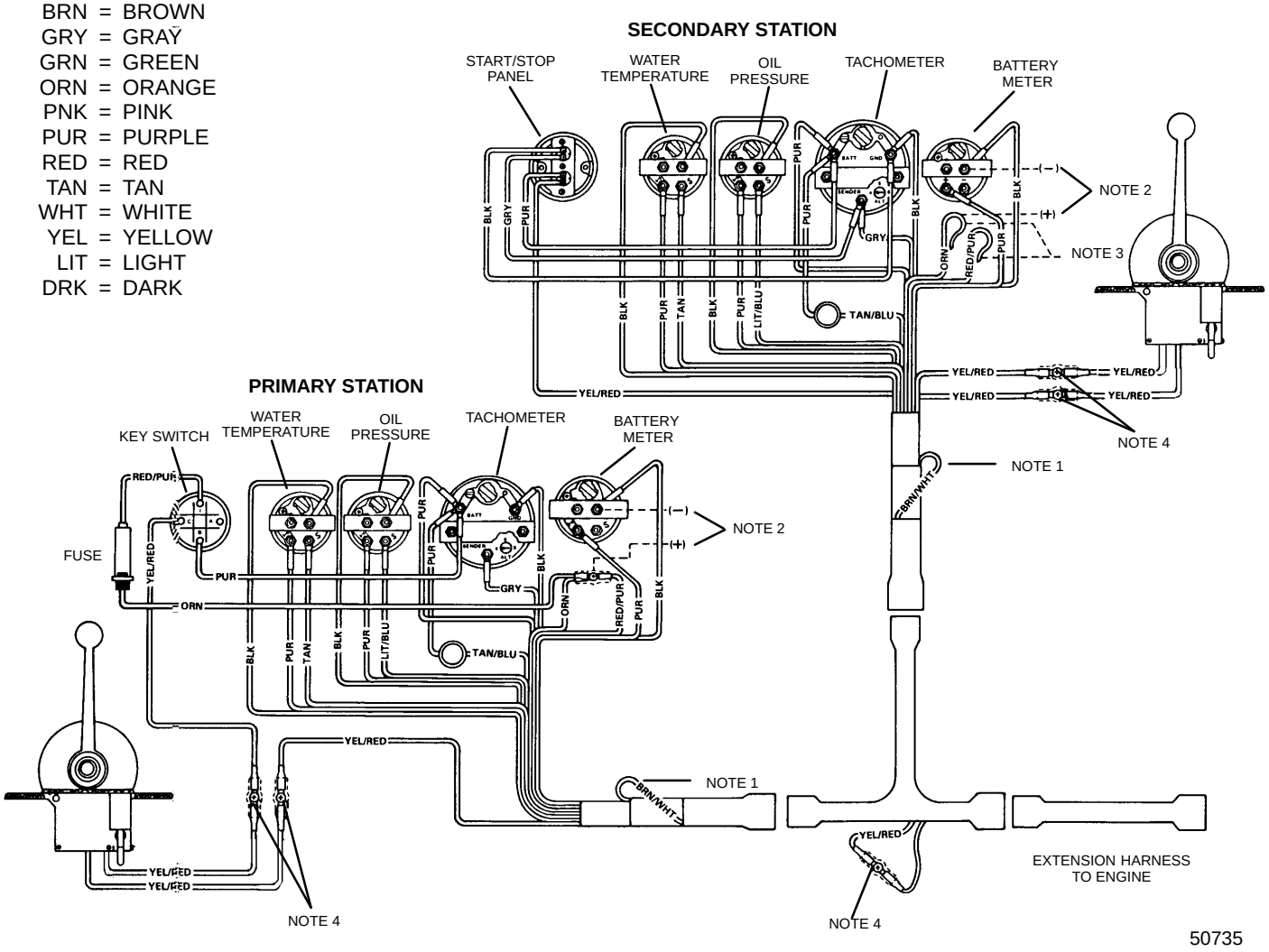
NOTE 2: An accessory fuse panel may be connected at this location. The combined current draw of the primary station and secondary station MUST NOT exceed 5 amps.

NOTE 3: Tape back and insulate with at least four layers of electrical tape.

NOTE 4: Connect wires together with screw and hex nut. Tighten securely and coat with Liquid Neoprene to help control corrosion; when dry, slide neoprene sleeve over connection.

BREAKER POINT IGNITION - DUAL STATION USING A NEUTRAL SAFETY SWITCH IN BOTH REMOTE CONTROLS

BLK = BLACK
BLU = BLUE
BRN = BROWN
GRY = GRAY
GRN = GREEN
ORN = ORANGE
PNK = PINK
PUR = PURPLE
RED = RED
TAN = TAN
WHT = WHITE
YEL = YELLOW
LIT = LIGHT
DRK = DARK



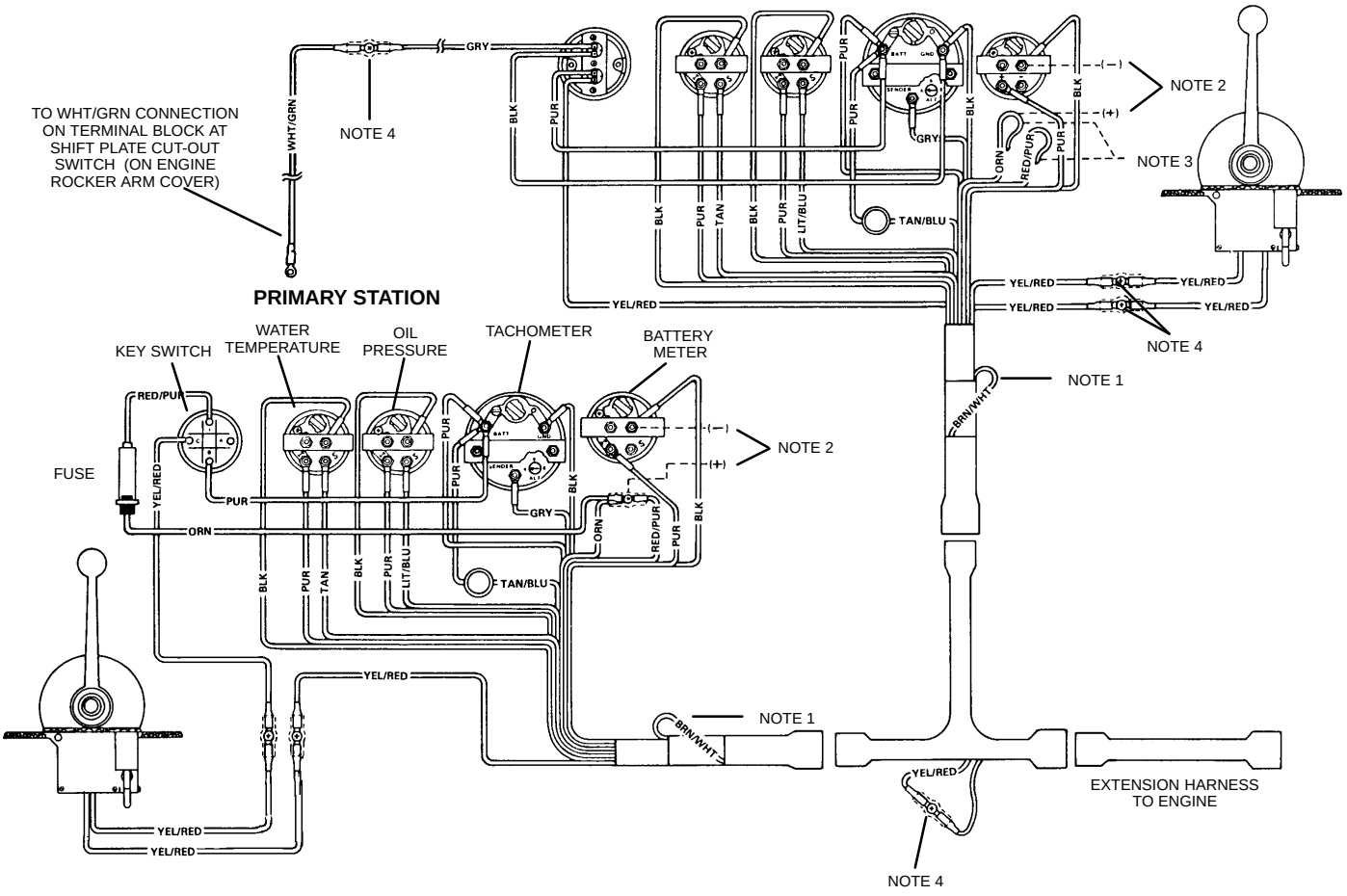
NOTE 1: BROWN/WHITE wire is taped back at instrument end. If installing on boat that is equipped with MerCruiser Stern Drive, BROWN/WHITE wire is connected to the trim sender terminal block. Also can be used for an accessory (limit 5 amps).

NOTE 2: An accessory fuse panel may be connected at this location. The combined current draw of the primary station and secondary station MUST NOT exceed 5 amps.

NOTE 3: Tape back and insulate with at least four layers of electrical tape.

NOTE 4: Connect wires together with screw and hex nut. Tighten securely and coat with Liquid Neoprene to help control corrosion; when dry, slide neoprene sleeve over connection.

EST AND DDIS IGNITION - DUAL STATION USING A NEUTRAL SAFETY SWITCH IN BOTH REMOTE CONTROLS



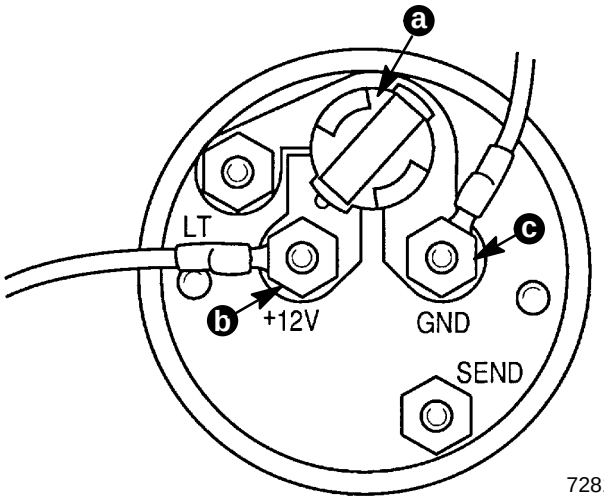
NOTE 1: BROWN/WHITE wire is taped back at instrument end. If installing on boat that is equipped with MerCruiser Stern Drive, BROWN/WHITE wire is connected to the trim sender terminal block. Also can be used for an accessory (limit 5 amps).

NOTE 2: An accessory fuse panel may be connected at this location. The combined current draw of the primary station and secondary station MUST NOT exceed 5 amps.

NOTE 3: Tape back and insulate with at least four layers of electrical tape.

NOTE 4: Connect wires together with screw and hex nut. Tighten securely and coat with Liquid Neoprene to help control corrosion; when dry, slide neoprene sleeve over connection.

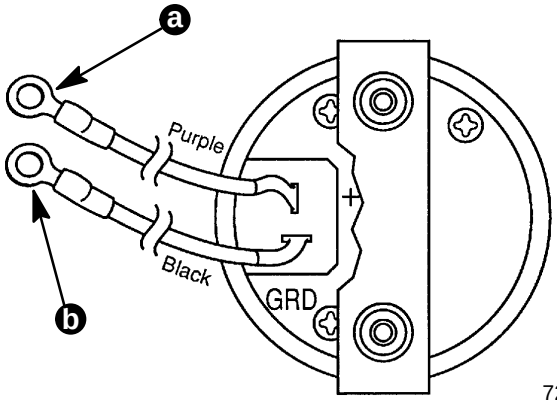
Battery Meter Gauge



72814

a - Lamp Mounting Hole
b - PURPLE (or WHITE) Jumper Wire from This Terminal to “I” (or +) Terminal on Water Temperature or Oil Pressure Gauge
c - BLACK Jumper Wire from This Terminal to Ground (–) Terminal on Water Temperature or Oil Pressure Gauge

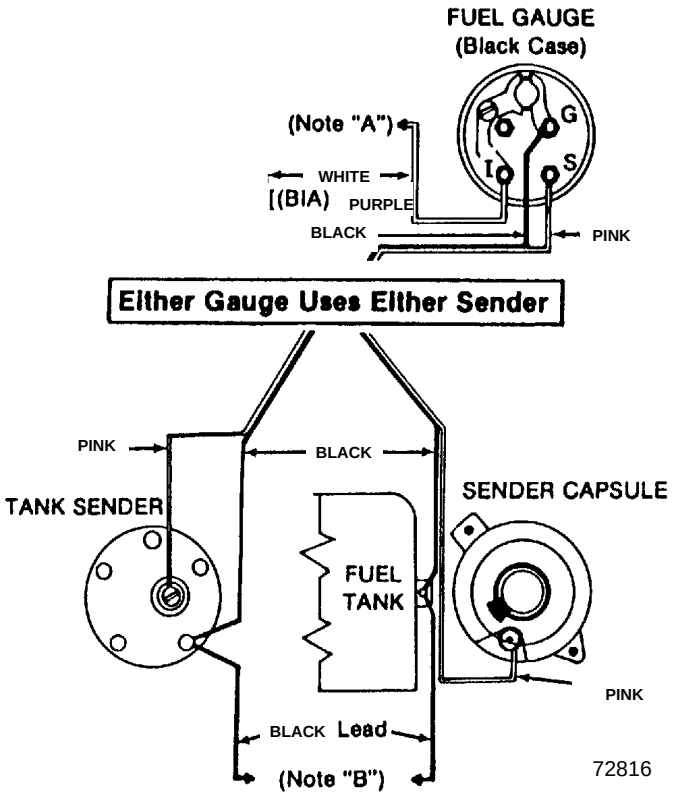
Cruiselog



72815

a - Connect to Ignition Switch Activated 12 Volt Positive (+) Source (PURPLE Wire)
b - Connect to Negative (–) Ground (BLACK Wire)

Fuel Gauge and Sender



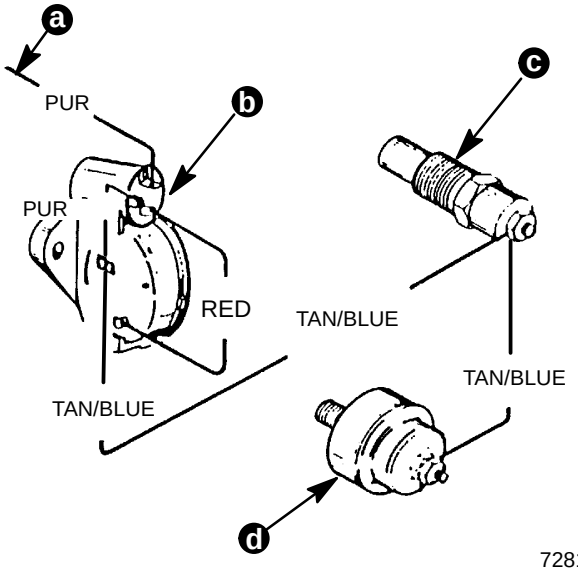
72816

NOTE “A”: Connect to “I” (Ignition) Terminal or Accessory Terminal of ignition switch.
NOTE “B”: Connect to NEGATIVE (–) Battery Terminal Or Suitable Ground (–).

Audio Warning System

⚠WARNING

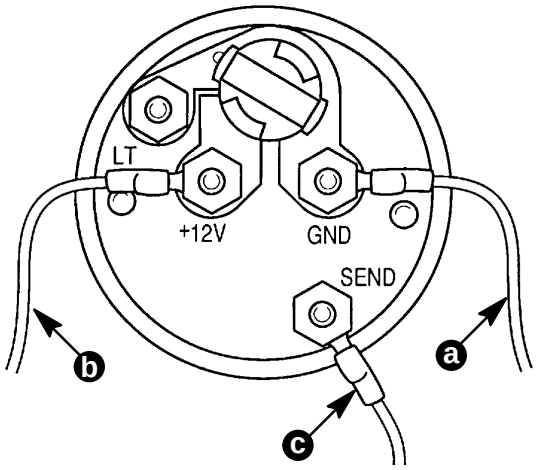
**Buzzer is not external ignition-proof; therefore, DO NOT mount buzzer in engine or fuel tank compart-
ments.**



72817

a - To 12 Volt (+) Positive Source
b - Audio Warning Buzzer
c - Water Temperature Heat Switch
d - Oil Pressure Switch

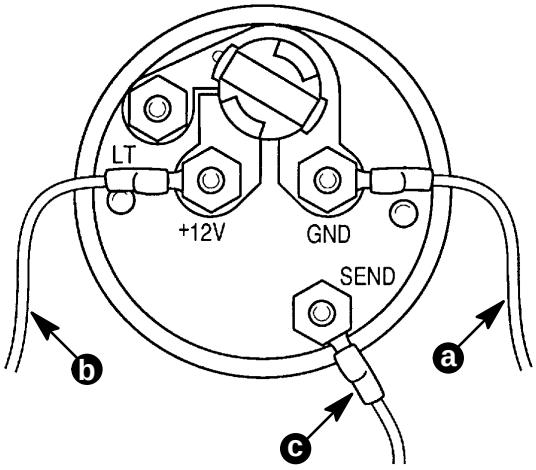
Water Temperature Gauge



72819

BIA Color Code		Leads to –
a	BLACK	(a) Ground (–)
b	PURPLE	(b) Switched 12 (+)_Volt Terminal
c	TAN	(c) Sender Lead

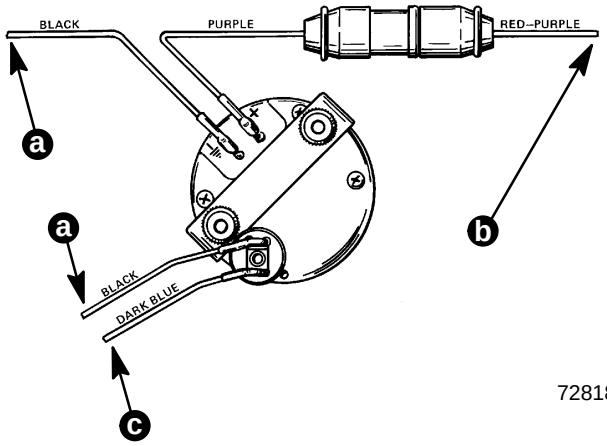
Oil Pressure Gauge



72819

BIA Color Code		Leads to –
a	BLACK	(a) Ground (–)
b	PURPLE	(b) Switched 12 Volt (+) Terminal
c	LIGHT BLUE	(c) Sender Lead

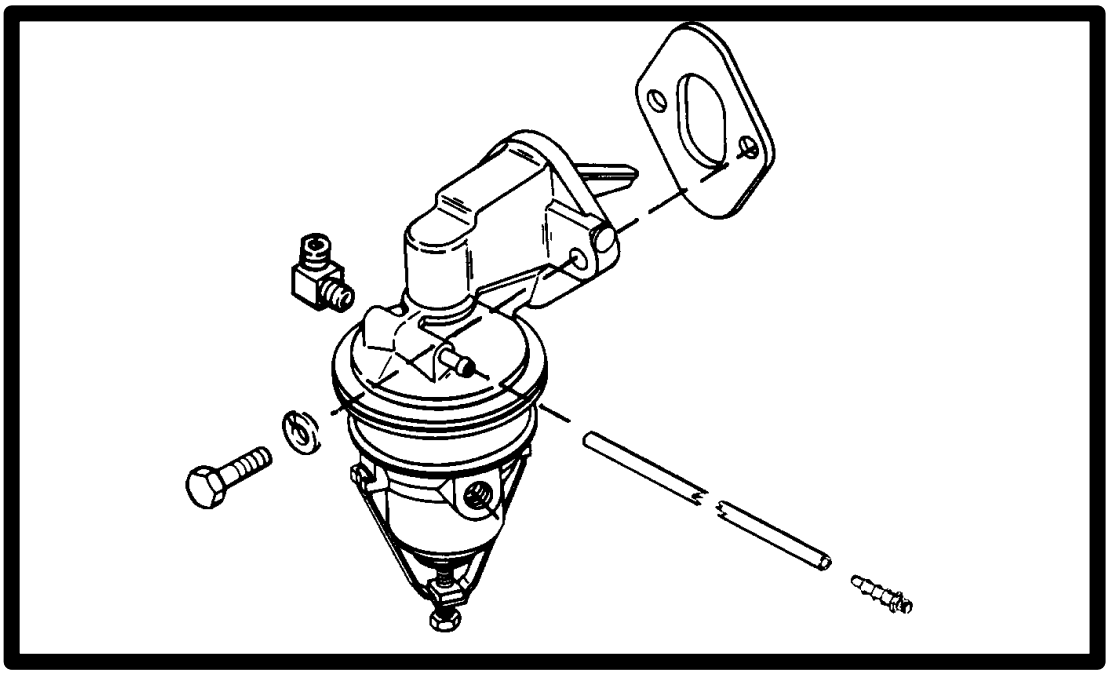
Clock



72818

a - Connect to a Terminal on an Adjacent Gauge or to Another Suitable Ground (–)
b - Connect to Instrument Harness RED/PURPLE Lead and Slide a
Rubber Sleeve over Connection
c - Connect to an “I” Terminal of an Adjacent Gauge or to Any Switched 12 (+) Volt Terminal

FUEL SYSTEM



FUEL PUMP

5

A

Index

Table of Contents

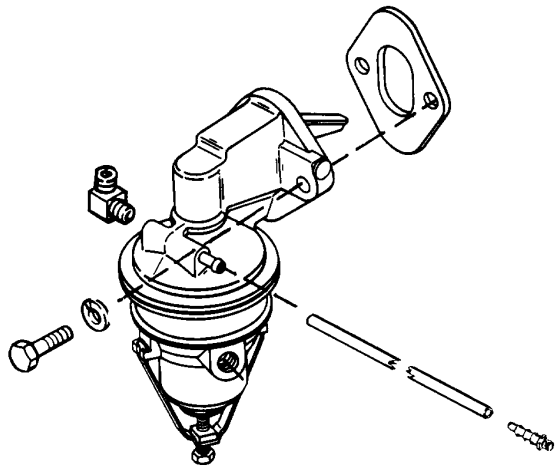
	Page
Identification	5A - 1
Replacement Parts Warning	5A - 1
Torque Specifications	5A - 1
Tools/Lubricants/Sealants	5A - 1
Specifications	5A - 1
Precautions	5A - 2
Fuel Delivery System	5A - 2
Recommendations	5A - 2
Description	5A - 2
Fuel System Components (Typical)	5A - 3
Water Separating Fuel Filter	5A - 3
Replacement	5A - 3
Fuel Pump Fuel Filter	5A - 4
Replacement	5A - 4
Testing Fuel Pump	5A - 4
Fuel Pump Replacement	5A - 5
Removal	5A - 5

NOTICE

For information and procedures on troubleshooting, refer to SECTION 1C.

Index

Identification



Carter Fuel Pump

Replacement Parts Warning

⚠WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

⚠WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel filter base can crack casting and/or cause a fuel leak.

- **Apply #592 Loctite Pipe Sealant with Teflon to threads of brass fitting or plug. DO NOT USE TEFLON TAPE.**
- **Thread brass fitting or plug into fuel filter base until finger tight.**
- **Tighten fitting or plug an additional 1-3/4 to 2-1/4 turns using a wrench. DO NOT OVER-TIGHTEN.**
- **Install fuel line. To prevent over-tightening, hold brass fitting with suitable wrench and tighten fuel line connectors securely.**
- **Check for fuel leaks.**

Torque Specifications

Description	Lb. Ft.	N·m
Fuel Inlet and Outlet Fittings	Tighten finger tight then 1-3/4 to 2-1/4 turns with wrench. (See Note)	
Fuel Line to Fuel Outlet Fitting	Securely	
Fuel Pump to Block	20	27

NOTE: *Apply #592 Loctite Pipe Sealant with Teflon. Do not use Teflon Tape.*

Tools/Lubricants/Sealants

Description	Part Number
Fuel Pressure Gauge	91-16850A1
Quicksilver Perfect Seal	92-34227-1
Quicksilver Needle Bearing Grease	92-42649A1
Obtain Locally	Loctite Pipe Sealant with TEFLON

Specifications

Type of Fuel Pump	Carter
Pump Pressure (1800 RPM)	5-1/4 - 6-1/4 PSI (36-44 kPa)

Index

Precautions

⚠WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or flame in the area while changing fuel filters. Wipe up any spilled fuel immediately.

⚠WARNING

Make sure that no fuel leaks exist before closing engine hatch.

⚠CAUTION

DO NOT operate engine without cooling water being supplied to seawater pickup pump, or pump impeller will be damaged and subsequent overheating damage may result.

⚠WARNING

Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel filter base can crack casting and/or cause a fuel leak.

- **Apply #592 Loctite Pipe Sealant with Teflon to threads of brass fitting or plug. DO NOT USE TEFLON TAPE.**
- **Thread brass fitting or plug into fuel filter base until finger tight.**
- **Tighten fitting or plug an additional 1-3/4 to 2-1/4 turns using a wrench. DO NOT OVER-TIGHTEN.**
- **Install fuel line. To prevent over-tightening, hold brass fitting with suitable wrench and tighten fuel line connectors securely.**
- **Check for fuel leaks.**

Fuel Delivery System

Recommendations

⚠WARNING

Boating industry standards (BIA, ABYC, etc.) federal standards and Coast Guard regulations MUST BE adhered to when installing fuel delivery system.

When designing and installing fuel delivery system, the following information MUST BE observed:

1. Fuel tank should be mounted below carburetor level, if possible. If tank is mounted above carburetor level, gravity feed may cause carburetor fuel inlet needle to unseat, and flooding may result.
2. Fuel pickup should be at least 1 in. (25 mm) from the bottom of the fuel tank to prevent picking up water or other impurities.
3. Fuel lines used MUST BE Coast Guard approved (USCG type A) and MUST NOT BE SMALLER THAN 3/8 in. (9.5 mm) I.D. On installations where long lines or numerous fittings are required, larger size lines should be used.
4. Fuel line should be installed free of stress and firmly secured to prevent vibration and/or chafing.
5. Sharp bends in fuel line should be avoided.
6. A flexible fuel line must be used to connect fuel line to engine to absorb deflection when engine is running.

Description

The fuel system consists of fuel tank(s), a water separating fuel filter, an electric fuel pump and a carburetor.

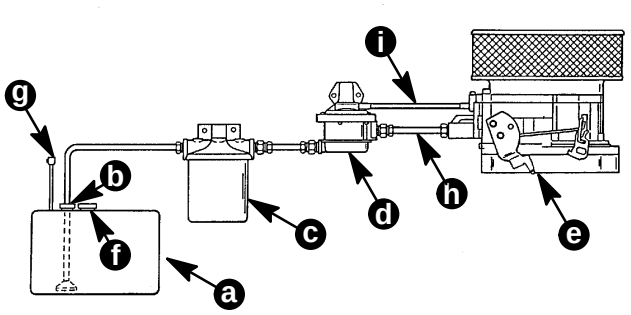
The fuel is stored in the fuel tank. When the fuel pump is energized by turning on ignition switch, fuel is drawn from the fuel tank, through the water separating filter, by the electric fuel pump.

The fuel is pushed through the fuel line to the carburetor where it is metered and supplied to the engine.

Index

Fuel System Components

FUEL SYSTEM



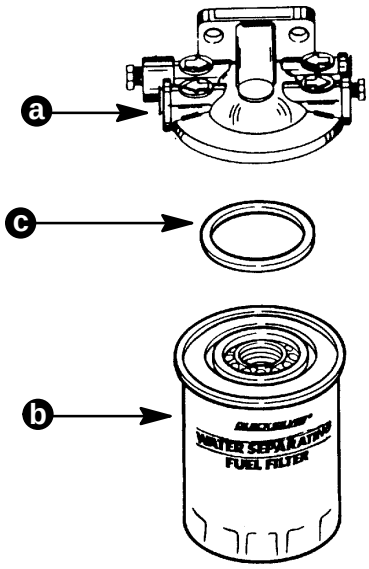
50830

Typical

a - Fuel Tank
b - Anti Siphon Valve
c - Water Separating Fuel Filter
d - Fuel Pump
e - Carburetor
f - Fuel Filter
g - Vent Hose
h - Fuel Line
i - Sight Tube

Water Separating Fuel Filter (If So Equipped)

The fuel filter consists of the fuel filter base and filter element.



72678

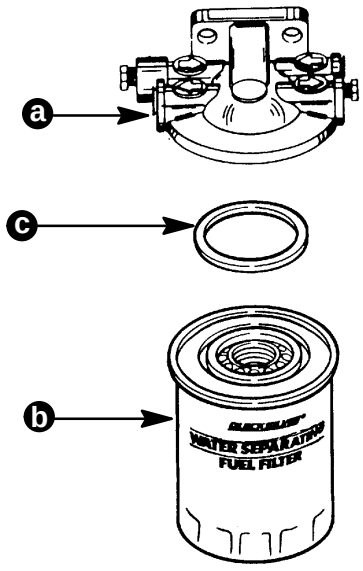
a - Filter Mounting Bracket
b - Filter Element
c - Sealing Ring

Filter should be replaced when fuel flow is restricted or filter flow is questionable. DO NOT attempt to flush out filter.

Replacement

NOTICE
Refer to "Precautions," in this section, BEFORE proceeding.

1. Disconnect battery cables from battery.
2. Remove fuel filter from base. A filter wrench may be needed to loosen element.
3. Lubricate sealing ring(s) of new filter with SAE engine oil.
4. Install new filter, tightening securely by hand.
5. Reconnect battery cables. Make sure water is supplied to cooling system and start engine. Check for fuel leaks.



72678

a - Filter Base/Mounting Bracket
b - Filter Element
c - Sealing Ring

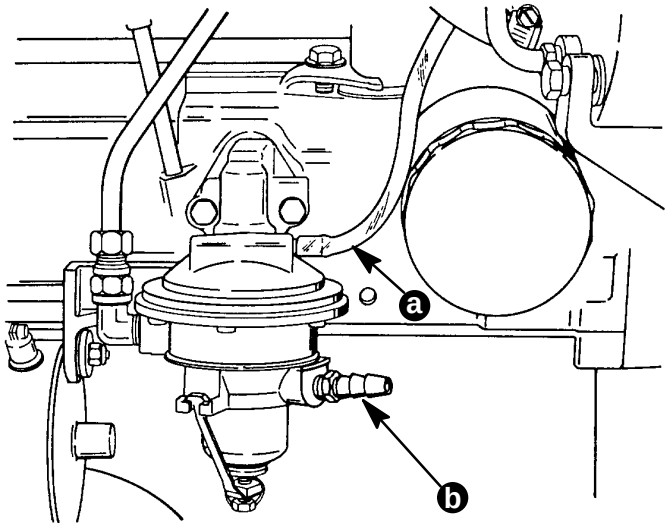
Fuel Pump Fuel Filter

NOTICE
Refer to "Precautions," in this section, BEFORE proceeding.

Replacement

INSPECTION

Fuel pumps are equipped with a sight tube. Any evidence of fuel in the sight tube indicates a ruptured diaphragm and fuel pump must be replaced immediately.



50738

a - Sight Tube
b - Fuel Fitting

NOTE: *This fuel pump must be replaced as an assembly; it is* ***not*** *repairable with a diaphragm kit.*

1. Disconnect battery cables from battery.

⚠CAUTION

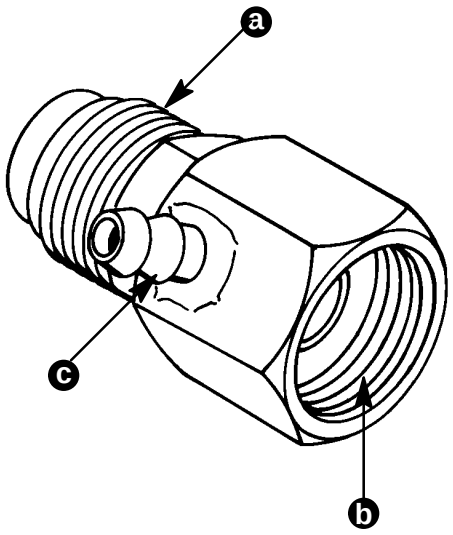
Plug fuel supply hose after removal to prevent fuel from leaking into boat.

2. Remove safety wire.
3. Loosen screw from filter bowl bail and release bail from fuel pump housing.
4. Remove bowl, filter element, spring, and gasket from fuel pump.
5. Install new filter.
6. Tighten retaining screw securely.
7. Install safety wire and tighten securely.
8. Start and run engine.
9. Check for gasoline leaks.
10. If leaks exist, STOP ENGINE and recheck connections.

Testing Fuel Pump

NOTICE
Refer to "Precautions," in this section, BEFORE proceeding.

1. Disconnect battery cables from battery.
2. Remove fuel line from carburetor or outlet side of fuel pump.
3. Install Fuel Pressure Connector (91-18078) to carburetor or fuel pump and reinstall fuel line. Tighten connector and fuel line securely.
4. Connect fuel pressure test gauge to connector.



71561

a – Fits into Carburetor
b - Fuel Line Connection
c - Fuel Gauge Barb

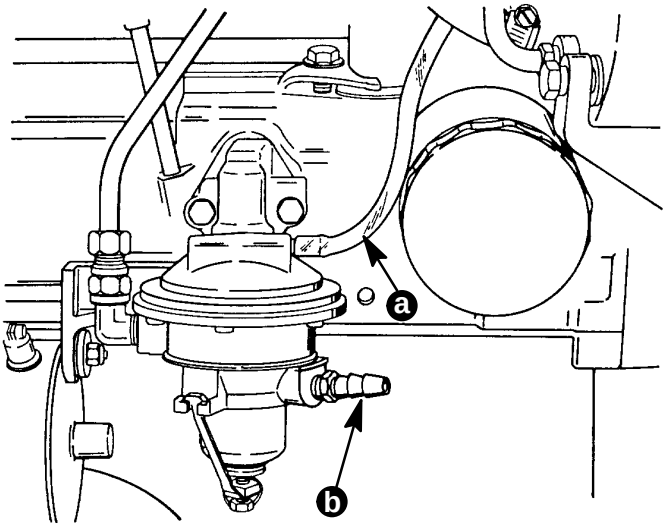
5. Reconnect battery cables, start engine, and run at idle, making sure water is supplied to the cooling system.
6. Fuel pressure should be within specifications. If not, replace fuel pump.
7. Remove fuel pressure gauge and connector tool. Reconnect fuel line to fuel pump.

Index

Fuel Pump Replacement

Removal

1. Remove fuel inlet and outlet lines at fuel pump.
2. Remove sight tube.



50738

a - Sight Tube
b - Fuel Fitting

3. Remove 2 fuel pump mounting bolts and lockwashers, pump and gasket.

⚠CAUTION

Plug fuel lines after disconnecting from fuel pump to eliminate any chance of fuel siphoning into bilge.

4. Install new gasket (coat both sides with Perfect Seal) on fuel pump. Install pump, and torque mounting bolts to specifications.

⚠WARNING

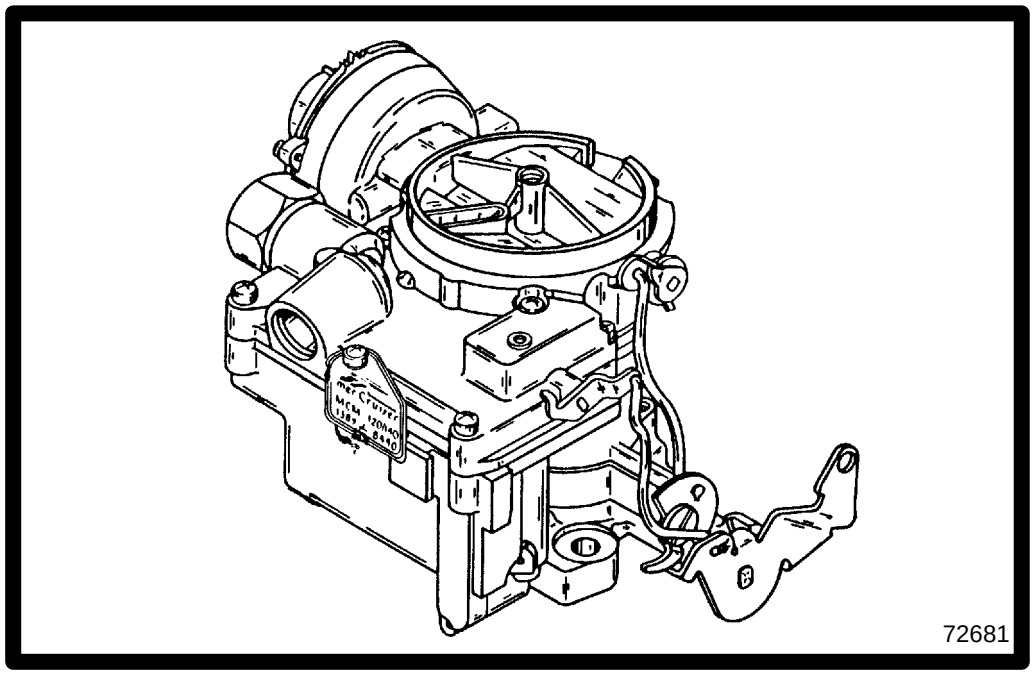
Avoid gasoline fire or explosion. Improper installation of brass fittings or plugs into fuel filter base can crack casting and/or cause a fuel leak.

- **Apply #592 Loctite Pipe Sealant with Teflon to threads of brass fitting or plug. DO NOT USE TEFLON TAPE.**
- **Thread brass fitting or plug into fuel filter base until finger tight.**
- **Tighten fitting or plug an additional 1-3/4 to 2-1/4 turns using a wrench. DO NOT OVER-TIGHTEN.**
- **Install fuel line. To prevent over-tightening, hold brass fitting with suitable wrench and tighten fuel line connectors securely.**
- **Check for fuel leaks.**

5. Install fuel outlet fitting (from old pump) into fuel pump.
6. Install fuel line to fuel outlet fitting. Tighten securely.
7. Install fuel inlet fitting to fuel pump.
8. Install sight tube and fuel supply line.
9. Start engine and check for fuel leaks.

Index

FUEL SYSTEM



MERCARB® 2 BARREL CARBURETOR

5

B

Index

Table of Contents

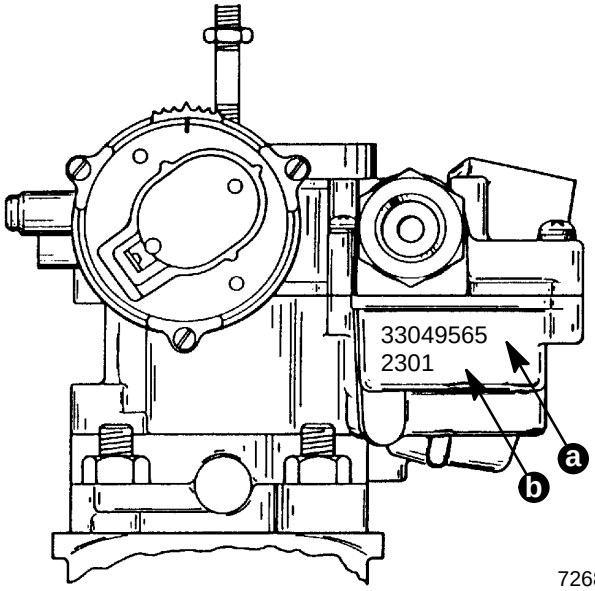
	Page
Identification	5B - 1
Replacement Parts Warning	5B - 1
Torque Specifications	5B - 1
Tools	5B - 1
Specifications	5B - 2
High Altitude Re-Jetting	5B - 3
Important Service Information	5B - 4
Flooding at Idle RPM	5B - 4
Needle/Seat Change	5B - 4
Adjustable Accelerator Pump Lever	5B - 4
Description	5B - 4
Precautions	5B - 5
Fuel Supply Connections	5B - 5
Maintenance	5B - 5
Flame Arrestor with Carburetor Cover	5B - 5
Fuel Inlet Filter	5B - 6
Choke Inspection	5B - 7
Adjustments	5B - 7
Pump Rod	5B - 7
Choke Setting	5B - 8
Choke Unloader	5B - 8
Preliminary Idle Speed and Mixture	5B - 9
Final Idle Speed and Mixture	5B - 9
Repair	5B - 10
Removal	5B - 10
Installation	5B - 10
Exploded View Parts List	5B - 13
Cleaning and Inspection	5B - 19
Reassembly	5B - 20

NOTICE

For information and procedures on troubleshooting, refer to SECTION 1C.

Index

Identification



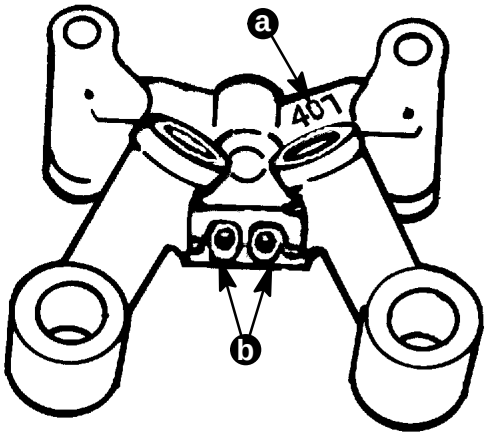
72680

a - Part Number
b - Date Code

Carburetor Part Number Location

Data Code Explanation: Example 2301

First Figure is Year:
2 = 1992, 3 = 1993, etc.
Second Figure is Month:
2 = February, 3 = March, etc.
X = October, Y = November, Z = December
Third and Fourth Figures are Day of Month:
01 = First day, 02 = Second day, etc.



72779

a - Identification Number (See Specifications)
b - Accelerator Pump Discharge Holes

Venturi Cluster Identification

Replacement Parts Warning

⚠ WARNING

Electrical, ignition and fuel system components on your MerCruiser are designed and manufactured to comply with U.S. Coast Guard Rules and Regulations to minimize risks of fire and explosion.

Use of replacement electrical, ignition or fuel system components, which do not comply with these rules and regulations, could result in a fire or explosion hazard and should be avoided.

Torque Specifications

Description	lb. ft.	N·m
Carburetor To Manifold	20	27
Fuel Line to Carburetor	18	24
Fuel Inlet Filter Nut	18	24

Tools

Description	Part Number
Tachometer	79-17391A1
Universal Carburetor Gauge	91-36392
Boroughs Special Tool and Equipment Inc. 2429 N. Burdick Street Kalamazoo,MI 49007 (616) 345-5163	
BT 8128 B	Float Gram Scale

Index

Specifications

UNIT OF MEASUREMENT In. (mm)

CARBURETOR ADJUSTMENT SPECIFICATIONS

Engine Model	3.0L		3.0LX	
Carburetor Type	MerCarb 36mm	MerCarb 43mm	MerCab 43mm	MerCab 43mm
Carburetor Number	1389-9562 3310-806077	1389-815396 3310-806078	3310-805924	1389-815397
Float Level	3/8 (10)			
Spring Loaded Needle	9/16 (14) (See Note)			
Float Drop	1-3/32 (27) (See Note)			
Pump Rod	1-5/32 (29)			
Choke Setting	Two Marks To The Lean Side			
Choke Unloader	5/64 [080] (2)			
Idle Mixture Screws	1-1/4 Turns			
Float Weight	9 Grams Maximum			
Primary Jet Size	1.45mm	1.60mm	1.60mm	1.65mm
Power Valve Size	0.74mm	0.74mm	0.74mm	0.84mm
Venturi Cluster I.D. Number	442	592	464	593
Accelerator Pump Discharge Hole Size	.025 (0.635)			

All measurements are ± 1/64 in. (0.4 mm).

NOTE: Float drop measured from air horn (with gasket in place) to toe of float.

Index

High Altitude Re-Jetting

Engine flooding problems, at idle RPM, are generally related to the altitude (above sea level) at which they are operated. If engine is running too rich at higher elevation, order a smaller jet from the chart. A jet stamped “165” is a 1.65 mm jet.

Model	Carburetor Part Number	500 Ft. (1525 m) and Below	5000-9000 Ft. (1525-2745 m)	9000 (2745 m) and Above
3.0L	1389-9562 3310-806077	1.45 mm Stock Jets	1.40 mm	1.35 mm
3.0L/3.0LX	1389-815396 3310-806078 3310-805924	1.60 mm	1.50 mm	1.45 mm
3.0LX	1389-815397	1.65 mm	1.55 mm	1.50 mm

JET SIZES

Jet Size	Quicksilver Part Number
1.30	3302-811849
1.35	3302-811850
1.40	3302-811851
1.45	3302-9050
1.50	3302-811852
1.55	3302-811853
1.60	3302810923
1.65	3302-9058
1.70	3302-9055
1.75	3302-881854
1.80	3302-811855
1.85	3302-811856
1.90	3302-811857

Index

Important Service Information

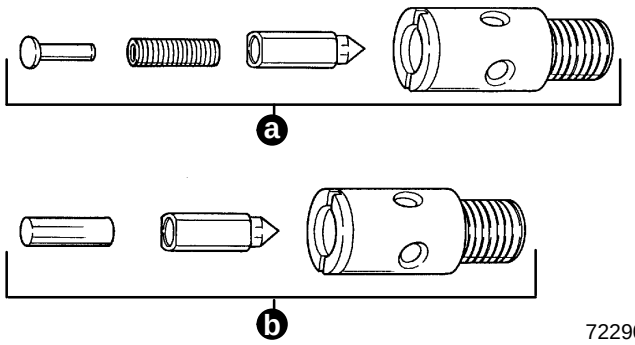
Flooding at Idle RPM

If your engine floods at idle RPM, check the following:

1. Problem in ignition system causing engine to run rough.
2. Idle mixture screw adjusted incorrectly.
3. Bad needle and seat.
4. Incorrect float level drop.

Needle/Seat Change

If the preceding steps failed to correct the problem, change the needle/seat to the other type. MerCarbs are equipped with either the solid or the spring loaded needle.



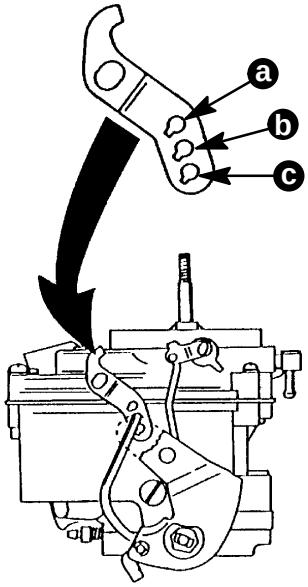
72290

a - Spring Loaded Type Needle (Kit 3302-9029)
b - Solid Type Needle (Kit 3302-9407)

Needle and Seat Assemblies

Adjustable Accelerator Pump Lever

This new 3-holed lever will allow you to change the amount of fuel delivered to the engine by the accelerator pump. The hole closest to the lever's shaft will give the same amount of fuel as the single hole lever did. The center hole gives approximately 0.5 cc less fuel and the hole farthest away will give about 1.0 cc less fuel.



73131

a - Full Accelerator Pump Stroke
b - 0.5 cc Less Fuel per Stroke
c - 1.0 cc Less Fuel per Stroke

The technician should be able to correct most "bogging" problems with this 3-holed lever, providing the "bogging" is caused by the carburetor. When installing the 3-holed lever, remove any metal ball that someone may have put in the accelerator pump well to limit pump travel. Also, make sure that the duration spring on the accelerator pump is stock and hasn't had several coils cut off. Make sure the venturi cluster is the correct one as outlined previously under "Specifications."

Description

This MerCarb carburetor is a two bore carburetor and has a separate fuel feed for each venturi. This model also is equipped with an electric choke. A removable venturi cluster (secured to float bowl assembly) has the calibrated main well tubes and pump jets built into it. The venturi cluster is serviced as a unit. The serviceable main metering jets are bleeds to properly meter the correct fuel/air mixture to the engine.

Index

Precautions

⚠WARNING

Always disconnect battery cables from battery BEFORE working on fuel system to prevent fire or explosion.

⚠WARNING

Be careful when cleaning flame arrestor and crankcase ventilation hose; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or open flame in area when cleaning flame arrestor and crankcase ventilation hose.

⚠WARNING

Be careful when changing fuel system components; gasoline is extremely flammable and highly explosive under certain conditions. Be sure that ignition key is OFF. DO NOT smoke or allow sources of spark or flame in the area while changing fuel filter. Wipe up any spilled fuel immediately.

⚠WARNING

Make sure no fuel leaks exist, before closing engine hatch.

Fuel Supply Connections

⚠CAUTION

DO NOT operate engine without cooling water being supplied to water pickup holes in gear housing, or water pump impeller will be damaged and subsequent overheating damage to engine may result.

Maintenance

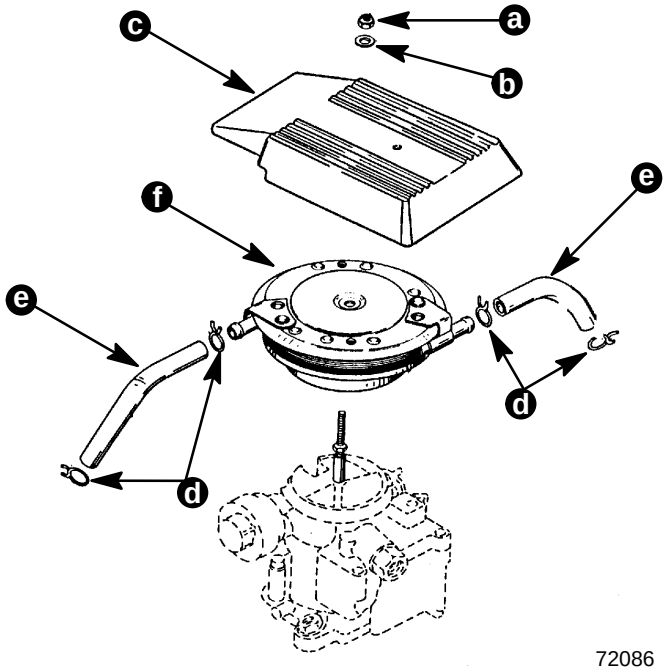
Flame Arrestor with Carburetor Cover

NOTICE
Refer to “Precautions,” in this section, BEFORE proceeding.

1. Remove in the following order:
   a. Nut.
   b. Sealing washer.
   c. Carburetor cover.
   d. Crankcase ventilation hoses from flame arrestor and rocker arm covers.
   e. Flame arrestor.

Index

2. Clean and inspect:
   a. Clean flame arrestor in solvent and blow dry with compressed air.
   b. Clean crankcase ventilation hoses.
   c. Inspect crankcase ventilation hoses for cracks or deterioration, and replace if necessary.
3. Install in the following order:
   a. Flame arrestor.
   b. Crankcase ventilation hoses to flame arrestor and rocker arm covers.
   c. Carburetor cover.
   d. Sealing washer.
   e. Nut (tighten securely).



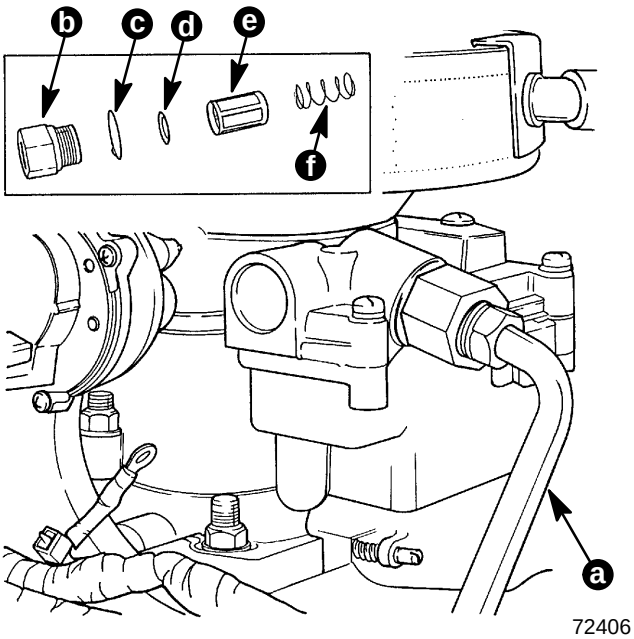
72086

a - Nut
b - Sealing Washer
c - Carburetor Cover
d - Cable Tie
e - Crankcase Ventilation Hose
f - Flame Arrestor

Fuel Inlet Filter

NOTICE
Refer to "Precautions," in this section, BEFORE proceeding.

1. Remove in the following order:
   a. Fuel line from fuel inlet filter nut.
   b. Fuel inlet filter nut and small gasket.
   c. Large gasket.
   d. Filter.
   e. Spring.
   f. Small gasket - from inside filter nut.



72406

a - Fuel Line
b - Fuel Inlet Filter Nut
c - Gasket (Large)
d - Gasket (Small)
e - Filter
f - Spring

2. Clean filter nut and spring in solvent and dry with compressed air.
3. Install in the following order:
   a. Spring - place in carburetor body.
   b. Filter - open end to inlet filter nut.
   c. Small gasket - place inside filter nut.
   d. Large gasket - place over filter nut threads.
   e. Fuel inlet filter nut - torque nut to 18 lb. ft. (24 N·m).
   f. Fuel line - torque to 18 lb. ft. (24 N·m).

Index

Choke Inspection

The choke does not require any periodic maintenance; however, if a choke malfunction is suspected, the following should be done:

1. With engine turned OFF, remove flame arrestor.
2. Open and close choke several times, and check for binding, loose or disconnected linkages, or other signs of damage.
3. If choke or linkage binds, sticks, or works sluggishly, clean with carburetor choke cleaner. Follow directions on can.

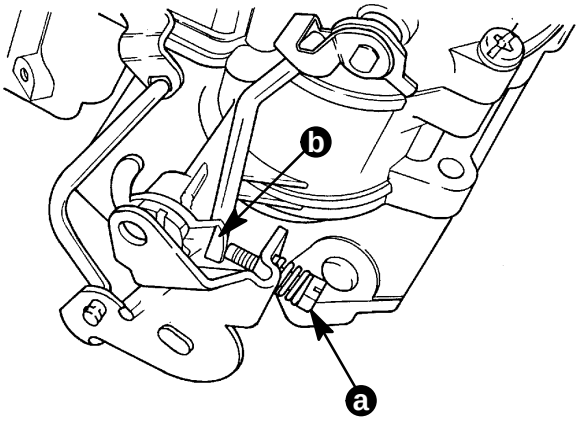
IMPORTANT: Choke valve and shaft and lever assembly is not serviceable. If valve and/or shaft and lever assembly is worn or damaged, air horn assembly must be replaced.

Adjustments

NOTICE
Refer to "Precautions," in this section, BEFORE proceeding.

Pump Rod

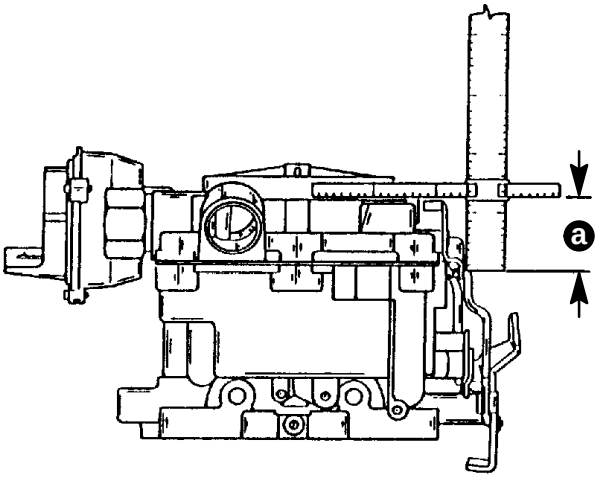
1. Back out idle speed screw until it no longer contacts idle cam.



72284

a - Idle Speed Screw
b - Idle Cam

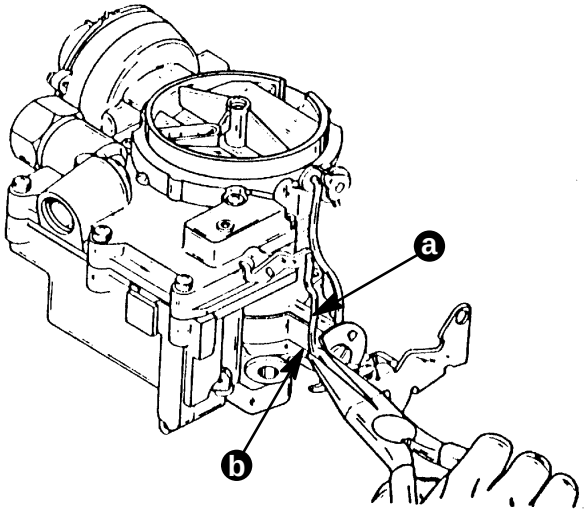
2. With throttle valves completely closed, measure from flame arrestor mounting surface to top of pump rod.



72682

a - See Specifications

3. Carefully bend pump rod (where shown) to obtain specified dimension.



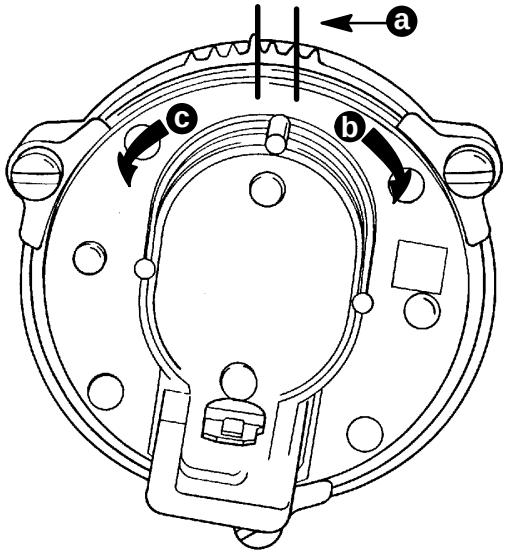
72683

a - Pump Rod
b - Bend Here

Index

Choke Setting

Normal choke setting is such that scribed mark on cover is in line with long case mark on choke housing.



72403

a - Scribed Mark
b - More Choke
c - Less Choke

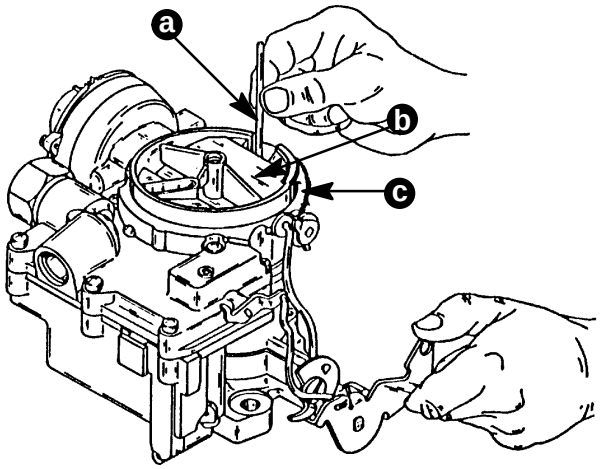
If choke adjustment is necessary:

1. Loosen three choke cover retaining screws and adjust as shown.
2. Tighten three choke cover retaining screws securely.

Choke Unloader

1. Hold throttle valves completely open.
2. Gently press down on choke plate.

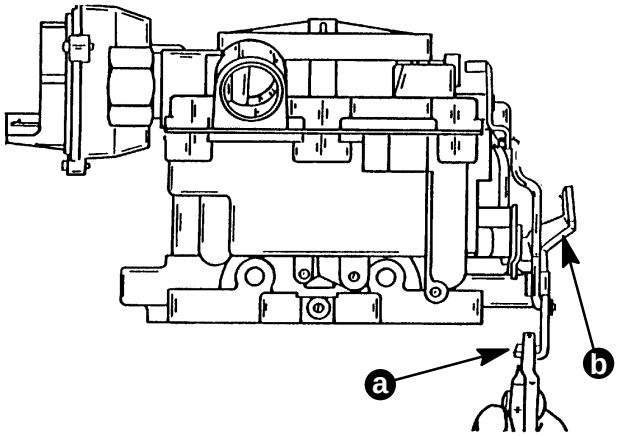
3. Using a .080 (5/64) in. drill rod, or or appropriate gauge,slide rod between upper edge of choke plate and air horn assembly. Rod should just slide through.



72684

a - .080 In. (0.2 mm) Drill Rod
b - Choke Plate
c - Air Horn

4. Bend tang on throttle lever, if necessary, to obtain specified dimension.



72685

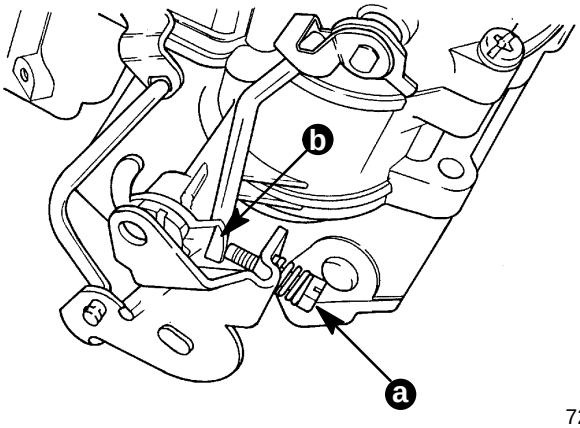
a - Tang
b - Throttle Level

Index

Preliminary Idle Speed and Mixture

IMPORTANT: The following adjustments will provide a sufficient idle speed and mixture for starting engine. Final adjustments must be made with engine running.

1. Back out idle speed screw until it no longer contacts idle cam. Turn idle speed screw in until it just contacts idle cam, then turn screw in an additional two turns.

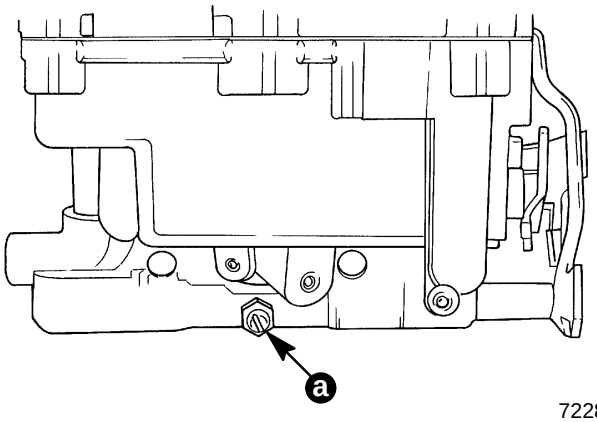


72284

a - Idle Speed Screw
b - Idle Cam

IMPORTANT: DO NOT turn idle mixture needle tightly against seat (in the following step), as damage to seat and/or needle may result.

2. Turn idle mixture needle in until lightly seated, then back needle out 1-1/4 turns.



72281

a - Idle Mixture Needle

Final Idle Speed and Mixture

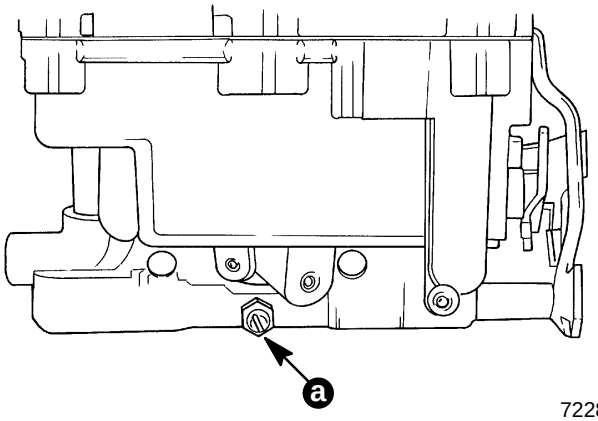
IMPORTANT: Boat must be in the water and engine at normal operating temperature to accurately check and adjust idle speed and mixture.

Carburetor should be set so that engine idles smoothly within range given under "Specifications," with boat in the water, engine at normal operating temperature and drive unit in forward gear. To adjust idle speed and mixture, proceed as follows:

IMPORTANT: DO NOT attempt to compensate for other engine problems (incorrect ignition timing, faulty ignition components, low compression, vacuum leaks, etc.) with carburetor adjustments. This will only cover the problem, which must be corrected if engine is to achieve maximum fuel economy and performance.

1. Connect an accurate shop tachometer to engine.

IMPORTANT: DO NOT turn idle mixture needle tightly into seat, as damage to needle and/or seat may result.



72281

a - Idle Mixture Needle

2. If new or rebuilt carburetor has been installed, turn idle mixture needle in (clockwise) until it lightly contacts seat, then back out needle 1-1/4 turns. This will provide a sufficient setting to allow starting engine.
3. Start engine and run at 1500 RPM until engine reaches normal operating temperature.

⚠WARNING

DO NOT leave the helm unattended while performing idle speed and mixture adjustments, following. BE CAREFUL NOT TO ACCIDENTALLY ACCELERATE ENGINE WHILE PERFORMING ADJUSTMENTS.

Index

4. With boat in open water, place remote control in forward gear, idle position.
5. Disconnect throttle cable barrel from anchor stud. Be sure not to lose spacer on anchor stud.
6. Adjust idle speed adjustment screw to obtain 550-600 RPM, in neutral gear.
7. With engine running at specified RPM, adjust idle mixture needle as follows:
   a. Turn idle mixture needle in (clockwise) until the engine speed begins to drop due to lean mixture.
   b. Turn idle mixture screw out (counterclockwise) until the speed begins to drop due to rich mixture.
   c. Turn screw in to a point between these two extremes to obtain maximum engine smoothness and RPM.
   d. Readjust idle speed adjustment screw until engine idles at 650-700 RPM in forward gear.

IMPORTANT: Refer to Section 2 - "Removal and Installation" for throttle cable installation and adjustment.

Repair

NOTICE

Refer to "Precautions," in this section, BEFORE proceeding.

Removal

IMPORTANT: Carburetor malfunctions are, in many cases, caused by the presence of dirt, water or other foreign matter in carburetor. To aid in diagnosis, carefully remove carburetor from engine without draining fuel from bowl. Contents of fuel bowl may then be inspected for contamination as carburetor is disassembled.

1. Remove ventilation hose from flame arrestor, then remove flame arrestor.

IMPORTANT: Place a clean cloth in bores of carburetor to prevent dirt and foreign material from falling into bores.

2. Turn fuel supply off at fuel tank.
3. Disconnect throttle cable from carburetor.
4. Remove fuel line from fuel inlet nut, using wrench to stabilize fuel inlet nut.
5. Remove fuel pump sight tube from carburetor.
6. Disconnect electric choke.
7. Remove carburetor attaching nuts and washers and remove carburetor.

IMPORTANT: Place a clean cloth over intake manifold opening to prevent dirt or foreign material from entering manifold.

8. Remove and discard gaskets.

Installation

1. Thoroughly clean gasket surfaces.
2. Place new carburetor base gasket on intake manifold. Install carburetor and secure with nuts and washers. Torque to 132 lb. in. (15 N·m).
3. If fuel inlet filter nut was disturbed, remove; clean all threads with brush and carburetor cleaner or Quicksilver Leveler.
4. Connect fuel line to fuel inlet filter nut, and while stabilizing filter nut with wrench, tighten fuel line fitting securely.
5. Connect fuel pump sight tube to fitting on carburetor.
6. Connect electric choke wires to choke cover.

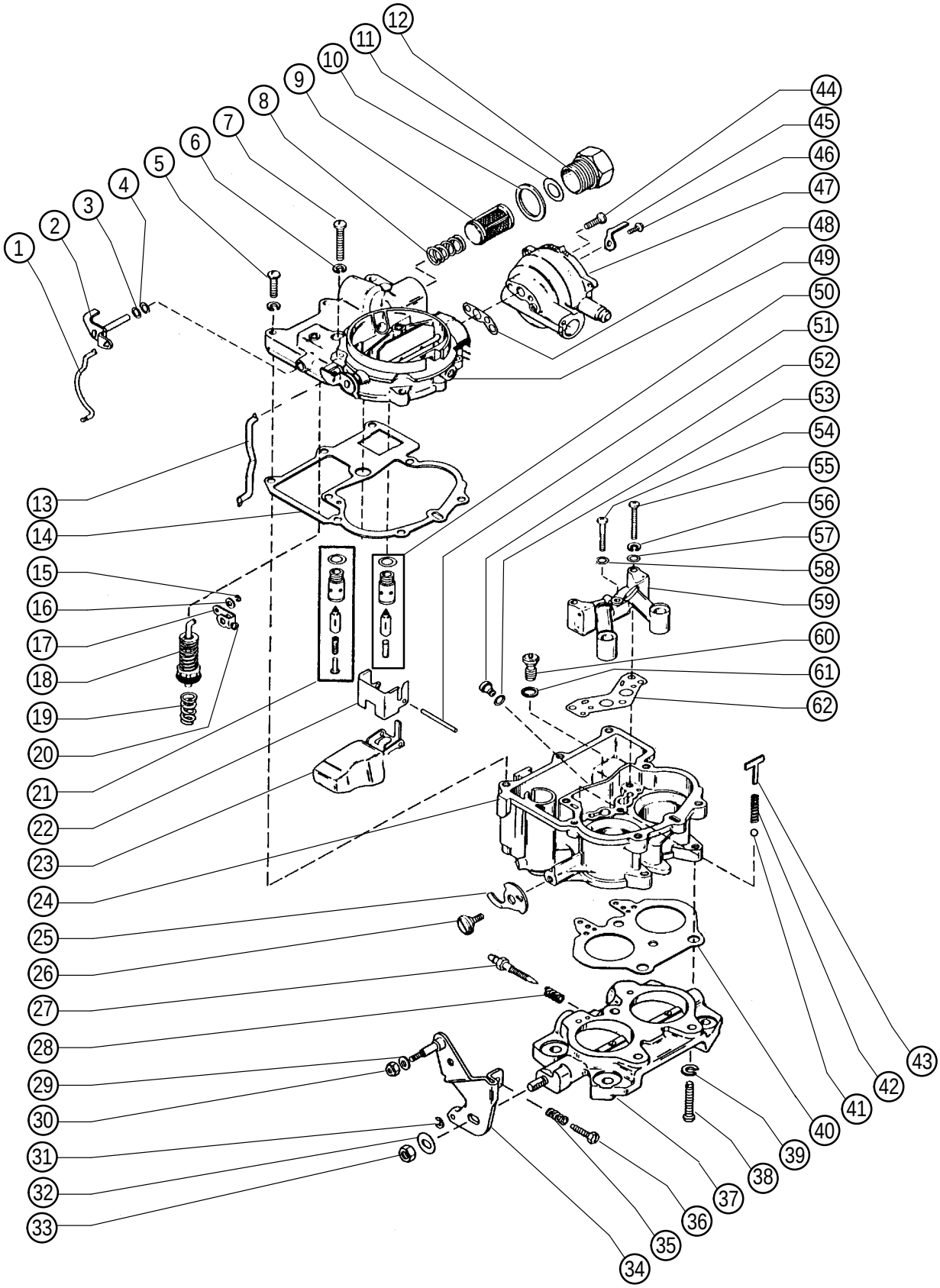
Index

7. Install throttle cable as explained in Section 2.
8. Install flame arrestor and crankcase ventilation hose.
9. Reconnect battery cables to battery.
10. Ensure that water is supplied to cooling system. Start engine and check for gasoline leaks. If leaks exist, STOP ENGINE IMMEDIATELY and re-check connections.
11. Adjust idle speed and idle mixture, as outlined under “Adjustments” as previously outlined.

The following is a step-by-step procedure for completely overhauling carburetor removed from engine. In many cases, however, complete overhaul is not necessary and, in these cases, only the steps required to repair the carburetor malfunction should be performed. Read the instructions carefully to prevent doing any unnecessary steps.

IMPORTANT: Before performing any service on carburetor, it is essential that carburetor be placed in a holding fixture to prevent possible damage to throttle valves.

Index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47
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49
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62

72686

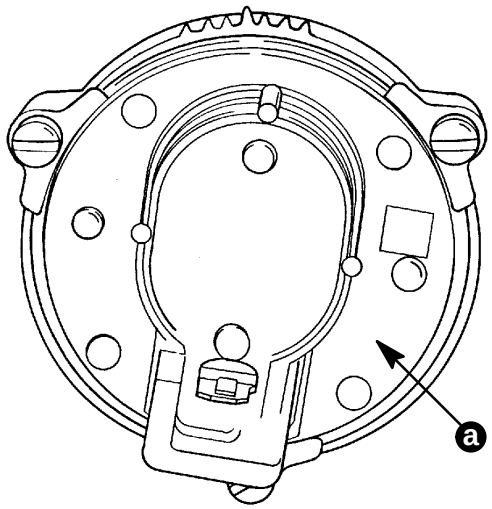
Index

Exploded View Parts List

1- Rod - Accelerator Pump
2- Accelerator Pump Shaft and Lever Assembly
3- Washer (Outer)
4 Washer (Inner)
5- Screw
6- Washer
7- Screw
8- Spring
9- Filter
10- Gasket
11- Gasket
12- Nut-Fuel Inlet
13- Choke-Rod
14- Gasket
15- Clip - Retainer
16- Washer
17- Pump Shaft and Lever Assembly
18- Accelerator Pump Assembly
19- Spring
20- Screw
21- Inlet Needle and Seat (Spring Loaded - Optional)
22- Baffle Plate
23- Float
24- Float Bowl
25- Cam-Idle
26- Screw
27- Idle Mixture Adjusting Needle
28- Spring
29- Washer
30- Nut
31- Clip-Pump Rod
32- Washer-Locking
33- Nut
34- Throttle Lever
35- Spring
36- Screw - Idle Speed Adjustment
37- Throttle Body
38- Screw
39- Washer
40- Gasket
41- Check Ball
42- Spring
43- Retainer
44- Screw
45- Lever Assembly
46- Screw
47- Choke/Housing
48- Gasket
49- Air Horn
50- Inlet Needle And Seat
51- Pin
52- Screw
53- Gasket
54- Screw
55- Screw
56- Flat Washer
57- Lock Washer
58- Gasket
59- Venturi Cluster
60- Power Valve Assembly
61- Gasket
62- Gasket

CHOKE HOUSING ASSEMBLY

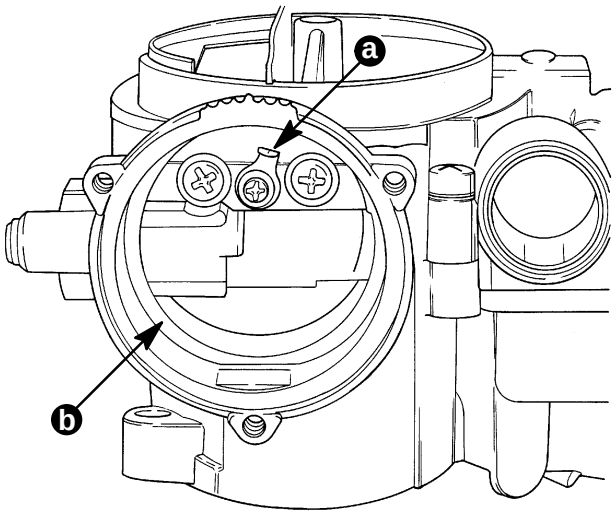
1. Remove choke cover.



72403

a - Choke Cover

2. Remove choke lever. Remove choke housing.



72401

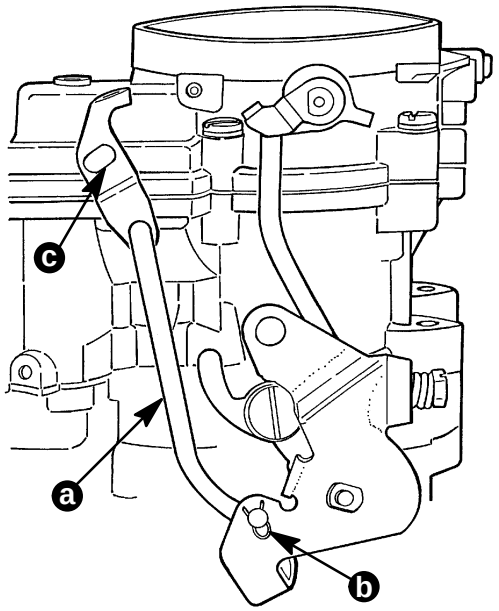
a - Choke Lever
b - Choke Housing

AIR HORN ASSEMBLY

1. Remove fuel inlet filter nut, washers, spring, and filter, as outlined previously.

Index

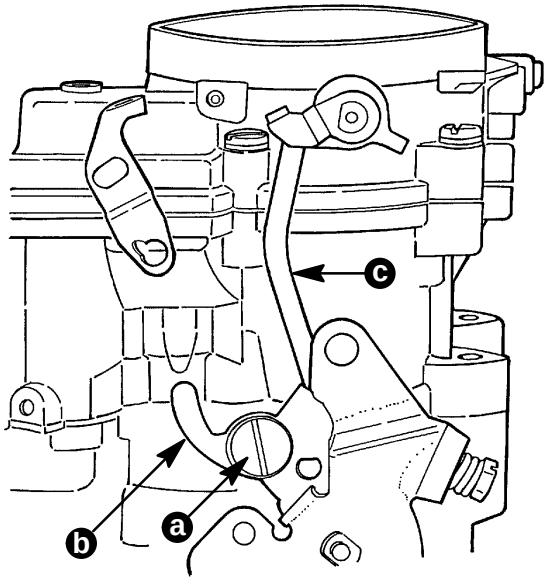
2. Remove accelerator pump rod retaining clip. Pivot rod (as required) until retaining ear on rod and slot in pump shaft and lever assembly align, allowing rod to be pulled out.



72283

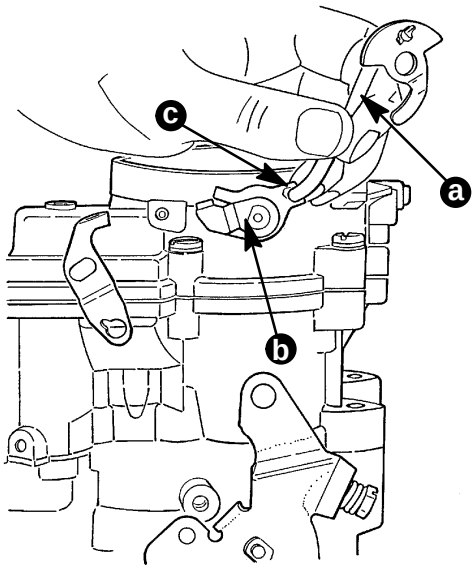
a - Accelerator Pump Rod
b - Retainer Clip
c - Pump Shaft and Lever Assembly

3. Remove idle cam screw. Also, remove choke rod by pivoting rod (as required) until retaining ear on rod and slot in choke lever align, allowing rod to be pulled out.



72282

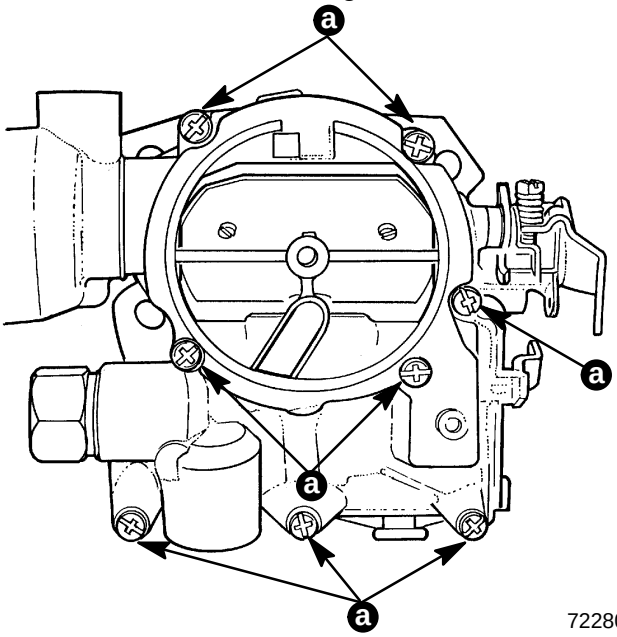
a - Idle Cam Screw
b - Idle Cam
c - Choke Rod



72286

a - Choke Rod
b - Choke Lever
c - Slot

4. Remove air horn attaching screws as shown.

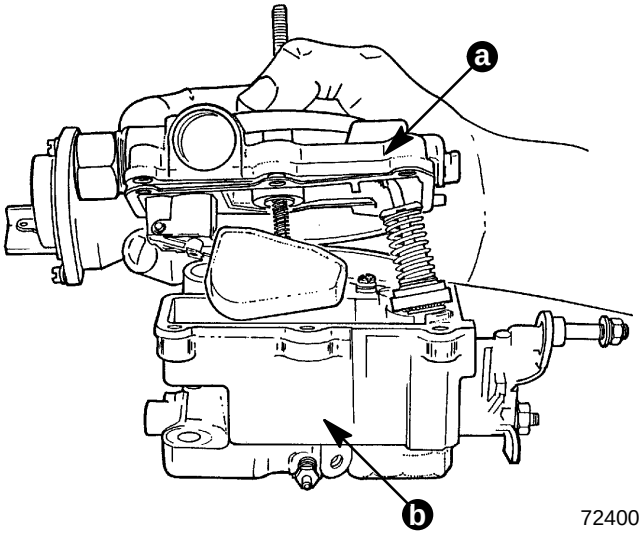


72280

a - Air Horn Attaching Screws

Index

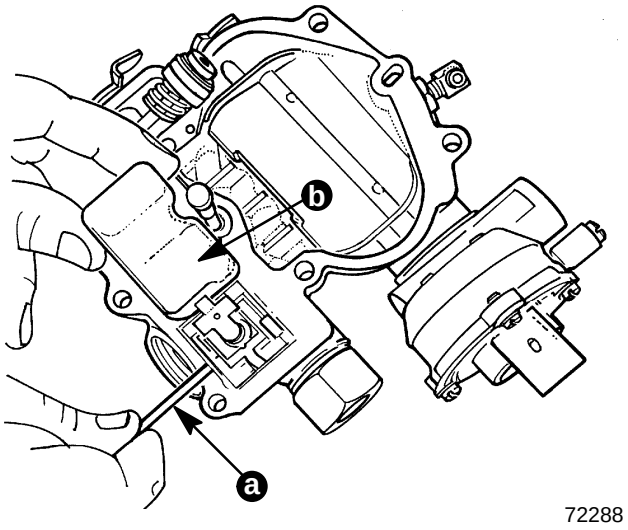
5. Carefully lift air horn from float bowl assembly.



a - Air Horn Assembly
b - Float Bowl Assembly

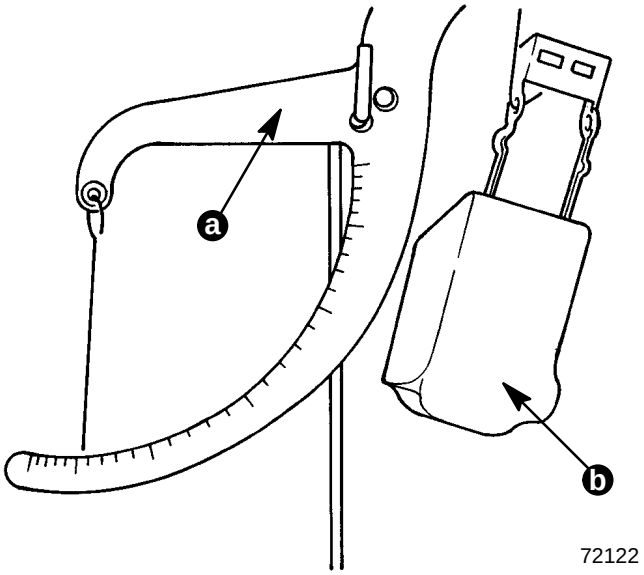
6. Invert air horn and carefully lay on bench.

7. Remove float hinge pin and lift float assembly from air horn.



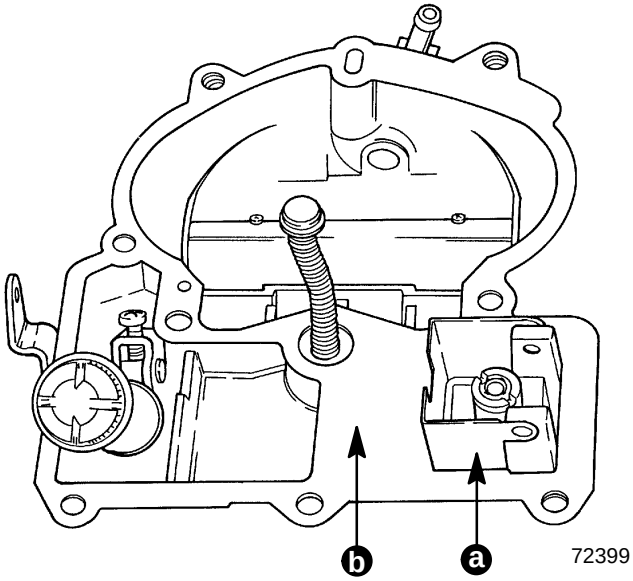
a - Float Hinge Pin
b - Float Assembly

8. Check float weight as shown.



a - Grams Scale
b - Float

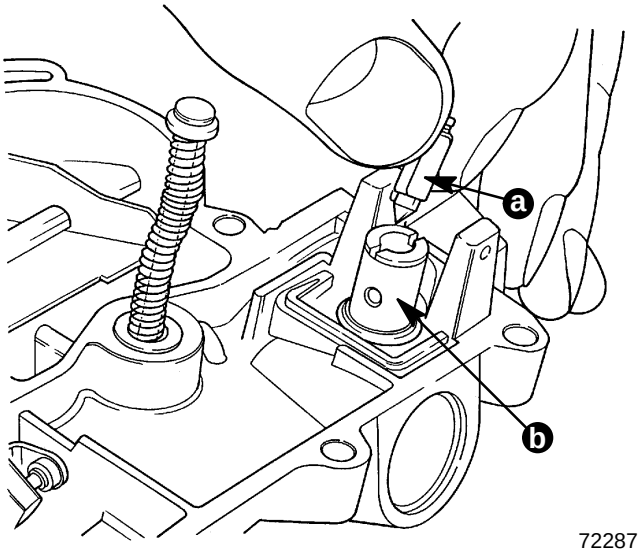
9. Remove air horn gasket and baffle.



a - Baffle
b - Air Horn Gasket

Index

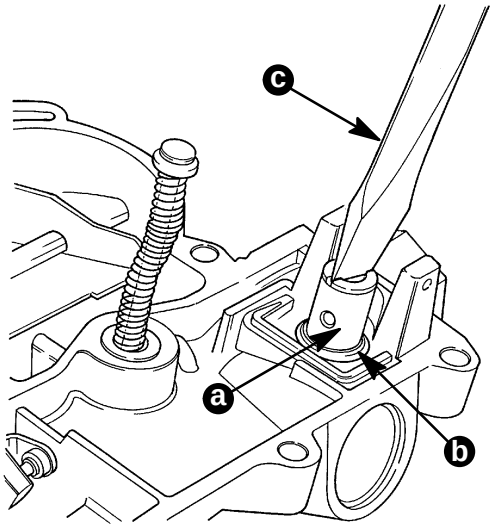
10. Remove needle assembly.



72287

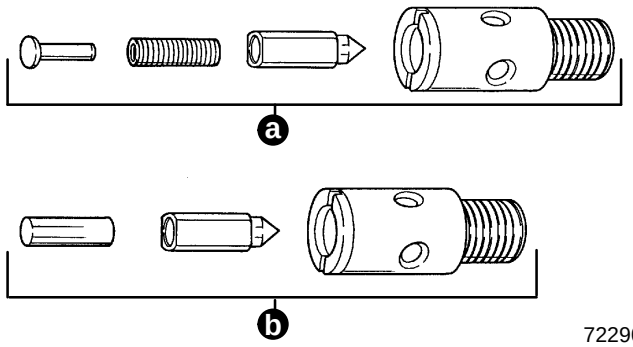
a - Needle Assembly
b - Needle Seat

11. Remove needle seat.



72289

a - Needle Seat
b - Gasket
c - Screwdriver

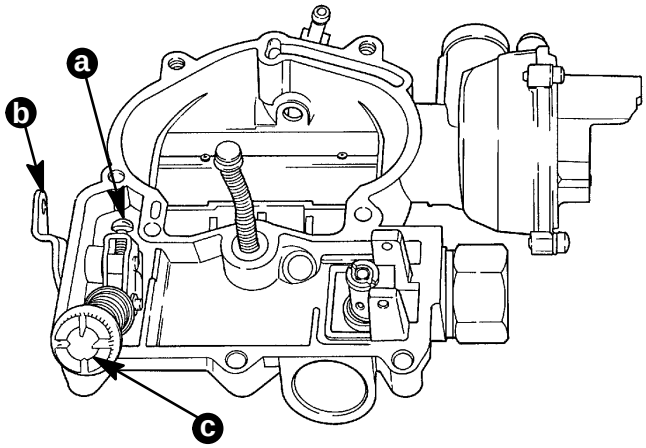


72290

a - Spring Loaded Type Needle (Kit 3302-9029)
b - Solid Type Needle (Kit 3302-9407)

Needle and Seat Assemblies

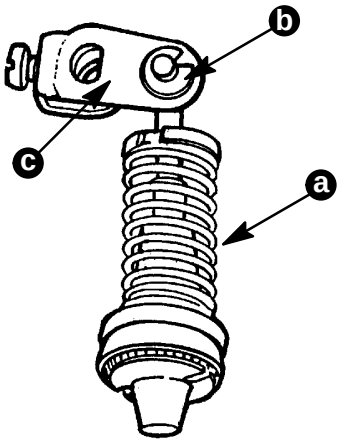
12. Loosen accelerator pump screw. Slide pump shaft and lever assembly (and washer) out of air horn, then remove accelerator pump assembly.



72398

a - Setscrew
b - Lever Assembly
c - Pump Assembly

13. Remove retainer clip and washer from pump shaft and lever assembly, then remove accelerator pump assembly.



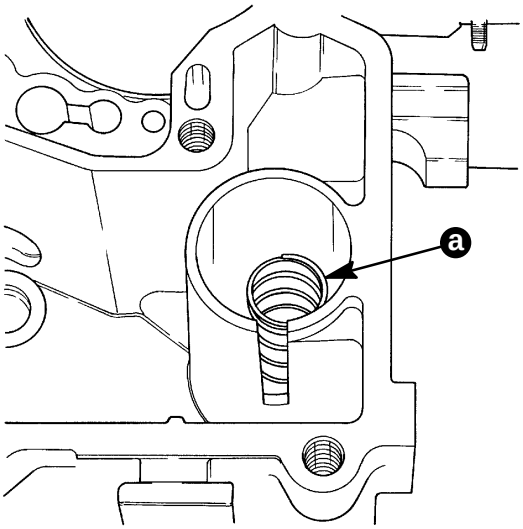
72409

a - Pump Assembly
b - Retainer Clip
c - Lever Assembly

Index

FLOAT BOWL ASSEMBLY

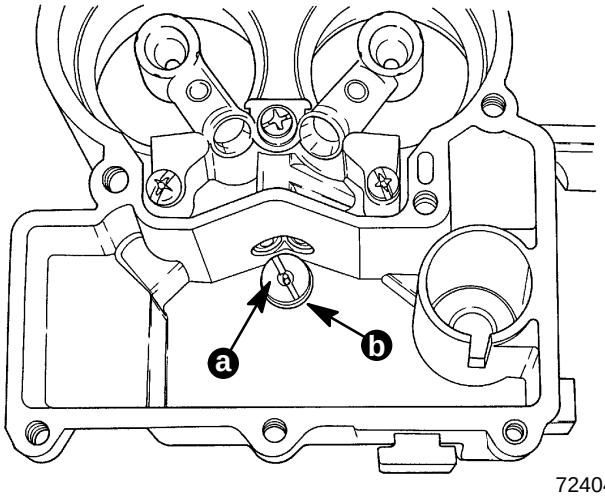
1. Remove accelerator pump return spring from pump well.



72402

a - Accelerator Pump Spring

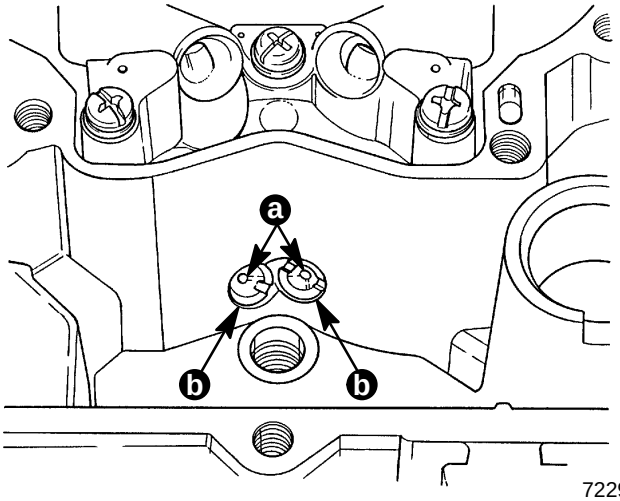
2. Remove power valve assembly and gasket.



72404

a - Power Valve Assembly
b - Gasket (Not Shown)

3. Remove main metering jets.

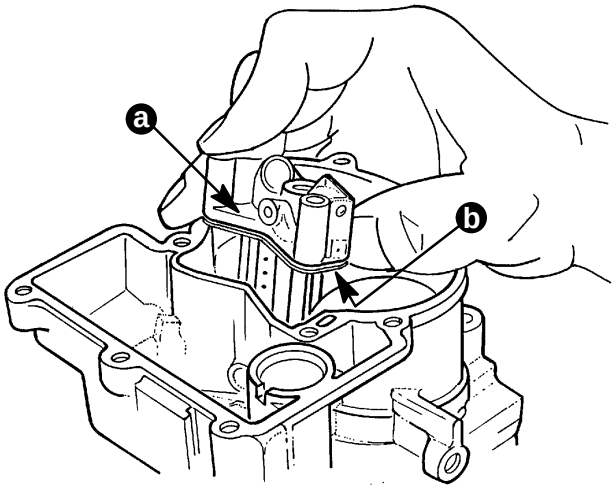


72291

a - Main Metering Jets
b - Gaskets (Not Shown)

IMPORTANT: Use care when removing venturi cluster to prevent damaging brass tubes which protrude from bottom of cluster. DO NOT REMOVE TUBES. These tubes are permanently pressed into the venturi cluster and are not replaceable.

4. Remove three venturi cluster screws, and carefully lift cluster and venturi gasket straight up.

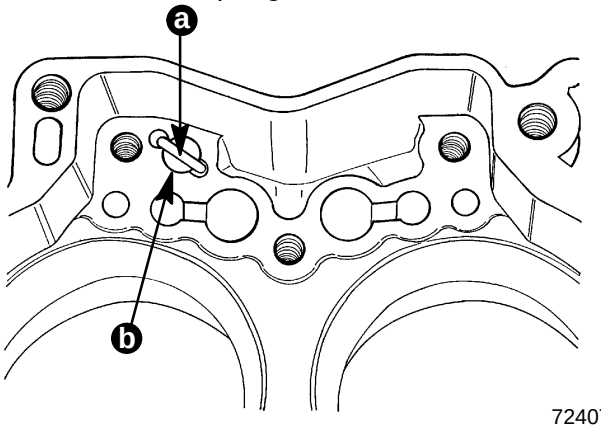


72292

a - Venturi Cluster Brass Tubes
b - Gasket

Index

5. Using a needle-nose pliers, remove accelerator pump check ball spring retainer. Turn float bowl over to remove spring and check ball.



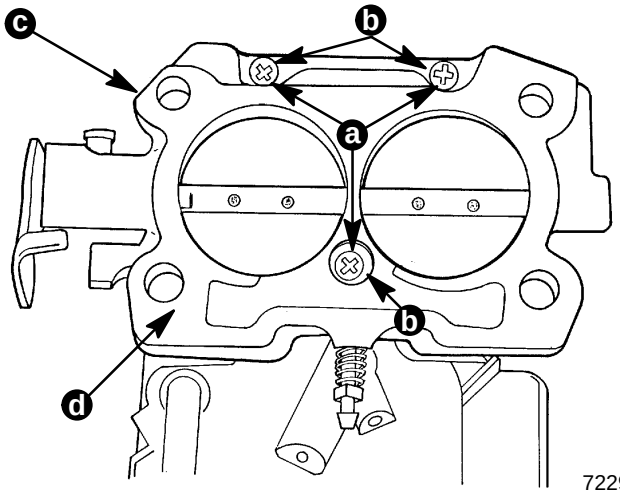
72407

a - Spring Retainer
b - Spring and Check Ball (Not Shown)

THROTTLE BODY ASSEMBLY

IMPORTANT: Use extreme care when handling throttle body, so as not to damage throttle valves.

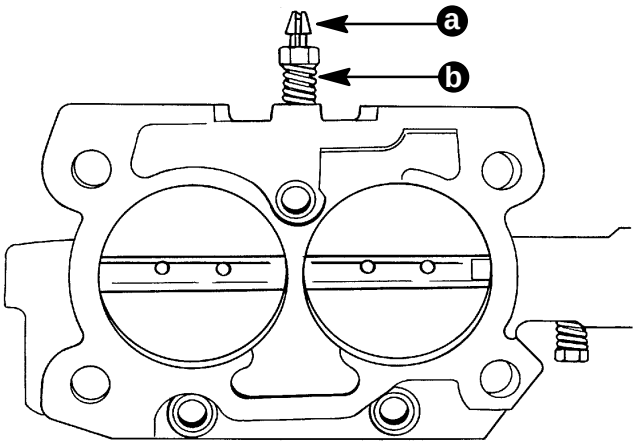
1. Place float bowl assembly upside down. Remove three throttle body assembly attaching screws and lockwashers, and remove throttle body and gasket from float bowl.



72294

a - Screws
b - Lockwashers (Not Shown)
c - Throttle Body
d - Gasket (Not Shown)

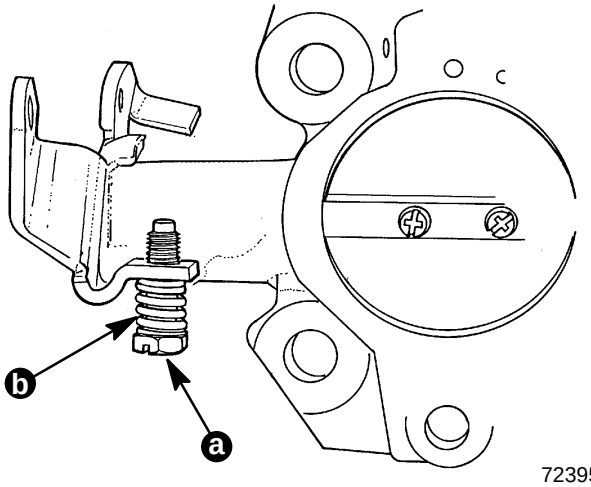
2. Remove idle mixture adjusting needle and spring.



72293

a - Idle Mixture Adjusting Needle
b - Spring

3. Remove idle speed adjustment screw and spring, if replacement is necessary.



72395

a - Idle Speed Screw
b - Spring

IMPORTANT: DO NOT remove throttle valves. If any of the throttle body parts are found to be worn or damaged, complete throttle body assembly MUST BE replaced. Throttle body assembly can be cleaned in carburetor cleaner.

Index

Cleaning and Inspection

IMPORTANT: DO NOT use a wire or drill to clean jet passages or tubes in carburetor, as this may enlarge orifices and seriously affect carburetor calibration.

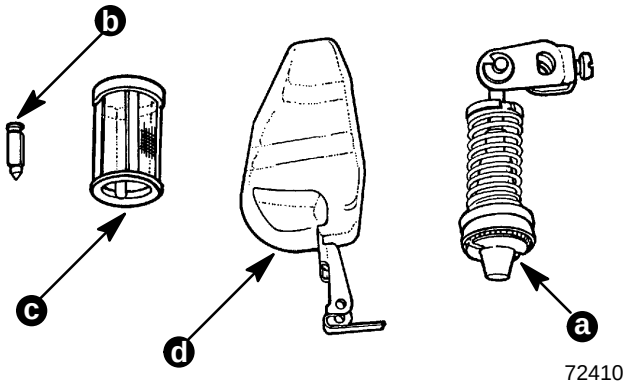
⚠CAUTION

To avoid damage to carburetor DO NOT leave carburetor in immersion type carburetor cleaner for more than two hours.

IMPORTANT: DO NOT clean float bowl gasket surfaces with a gasket scraper or knife, as sealing bead will be damaged and float bowl replacement will be necessary.

⚠CAUTION

The float assembly, float needle, accelerator pump plunger, and fuel filter MUST NOT BE immersed in carburetor cleaner, as they will swell, harden, and/or distort.



72410

a - Accelerator Pump Plunger
b - Float Needle
c - Fuel Filter
d - Float Assembly

⚠WARNING

Avoid personal injury by always wearing safety goggles when using compressed air.

1. Thoroughly clean all metal parts in a commercial carburetor cleaner, until all deposits have been removed. Follow cleaner manufacturer's instructions for proper cleaning and rinsing procedure. Dry parts with compressed air.
2. Using compressed air, blow out all passages in carburetor to remove any foreign material.
3. Wipe off all parts that cannot be cleaned in carburetor cleaner with a clean, dry cloth.
4. Carefully inspect all carburetor parts for wear and damage; pay particular attention to the following:
   a. **Float Needle and Seat**: If float needle or seat is worn or damaged, replace with new needle and seat assembly.

IMPORTANT: Float needle and seat are factory matched and tested and should be replaced as a set only.

   b. **Float Assembly and Hinge Pin:** Check float density (to see if it is saturated with fuel) by comparing weight of float with specifications. If weight is high, float assembly must be replaced. Check hinge pin and holes for wear.
   c. **Fuel and Air Passages:** Passages must be perfectly clean for proper carburetor operation.
   d. **Accelerator Pump Plunger and Return Spring:** Inspect pump plunger cup, pump plunger spring (on pump assembly) and return spring.
   e. **Power Piston Spring:** Check power piston spring for weakness or distortion.
   f. **Idle Mixture Needle:** Inspect idle mixture needle. If damaged, needle must be replaced.
   g. **Levers and Linkages:** Check levers, links and rods for wear.
   h. **Throttle Valve and Shaft:** Check throttle shaft for excessive looseness in throttle body. Check throttle valve and shaft for binding through entire operating range, making sure valve opens and closes completely. Throttle body assembly must be replaced if throttle valve and shaft are worn or damaged.
   i. **Choke Valve and Shaft and Lever Assembly:** Check shaft and lever assembly for excessive looseness in air horn assembly. Check choke valve and shaft and lever assembly for binding through entire operating range, making sure valve opens and closes completely. Air horn assembly must be replaced if choke valve and shaft and lever assembly are worn or damaged.
   j. **Inspect Casting** for visible damage. Inspect gasket surfaces. Inspect accelerator pump plunger well for scoring or deposits.

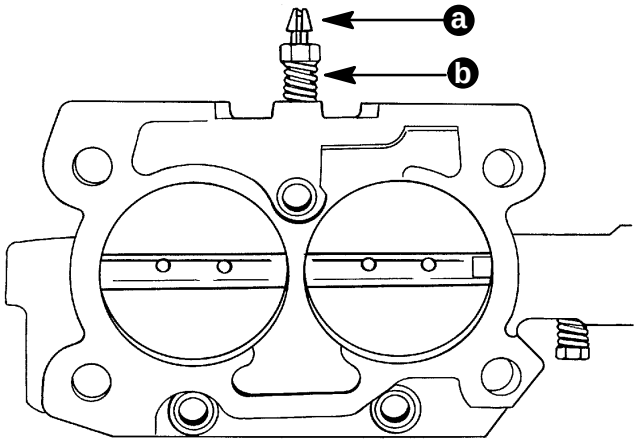
Index

Reassembly

THROTTLE BODY ASSEMBLY

IMPORTANT: DO NOT force idle mixture needle against seat as damage to needle and/or seat will result.

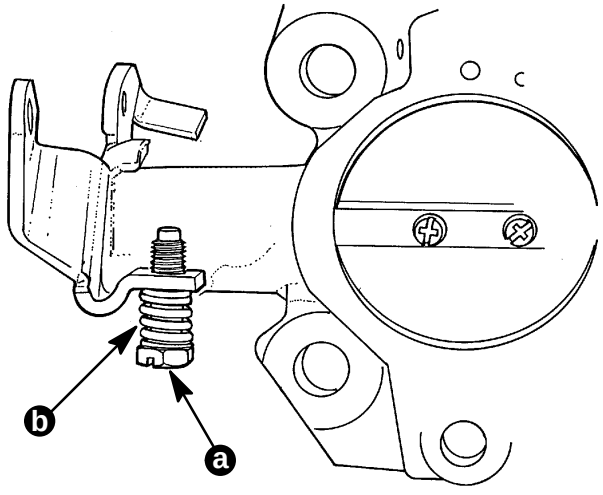
1. Screw idle mixture needle (and spring) into throttle body until they lightly seat, then back out needle 1-1/4 turns as a preliminary idle mixture setting. Final adjustment will be made with engine running. Refer to “Adjustments.”



72293

a - Idle Mixture Adjusting Needle
b - Spring

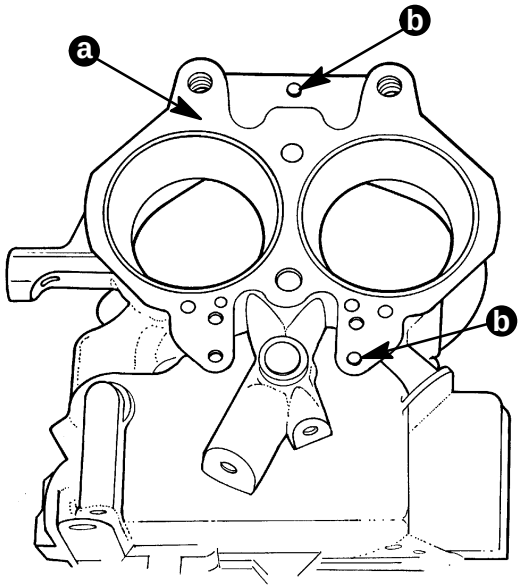
2. Thread idle speed adjustment screw and spring into throttle lever.



72395

a - Idle Speed Screw
b - Spring

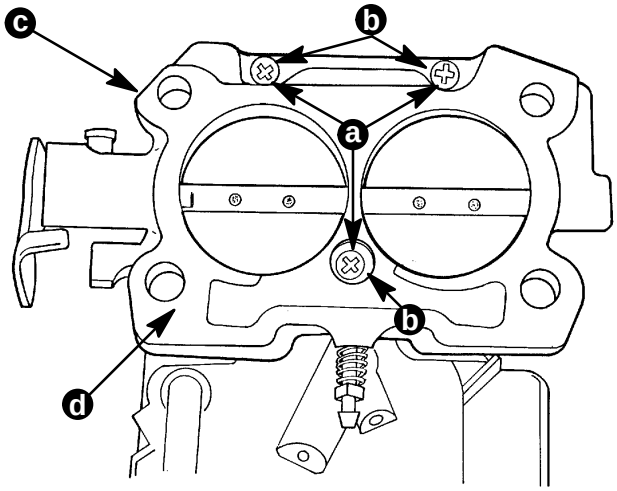
3. Turn float bowl assembly upside down and place new throttle body gasket on bowl, making sure gasket is properly positioned on location dowels.



72295

a - Throttle Body Gasket
b - Locating Dowels

4. Install throttle body assembly on float bowl assembly, making sure that screw holes in gasket line up with screw holes in throttle body. Tighten screws evenly and securely.



72294

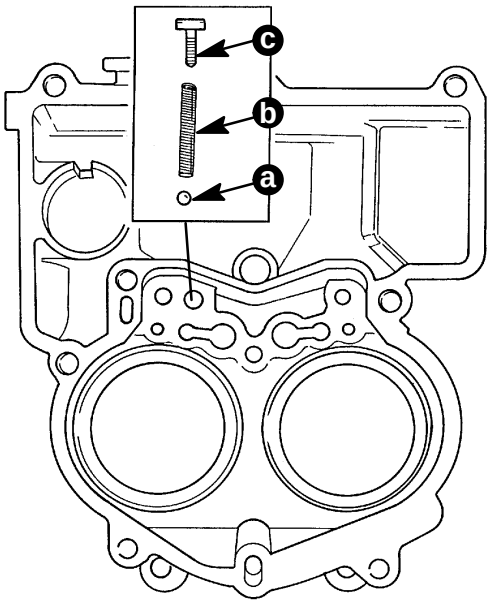
a - Screws
b - Lockwashers (Not Shown)
c - Throttle Body Assembly
d - Gasket

Index

FLOAT BOWL ASSEMBLY

IMPORTANT: Place float bowl and throttle assemblies in holding fixture to prevent throttle valves from being damaged.

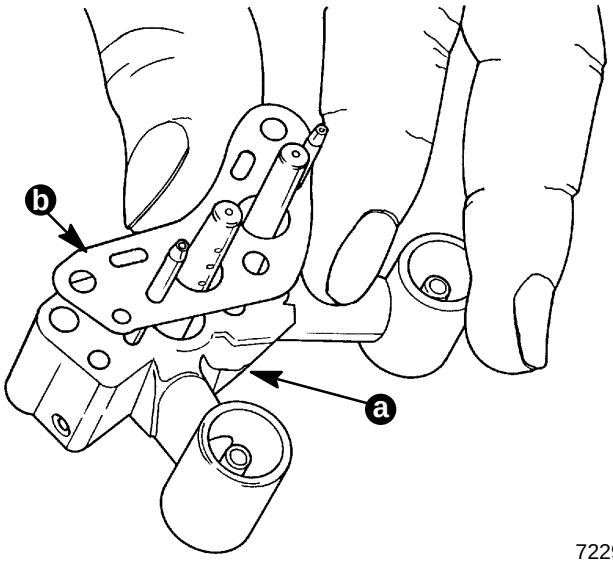
1. Install check ball, spring, and retainer in passage as shown. Push retainer firmly into slots.



72408

a - Check Ball
b - Spring
c - Retainer

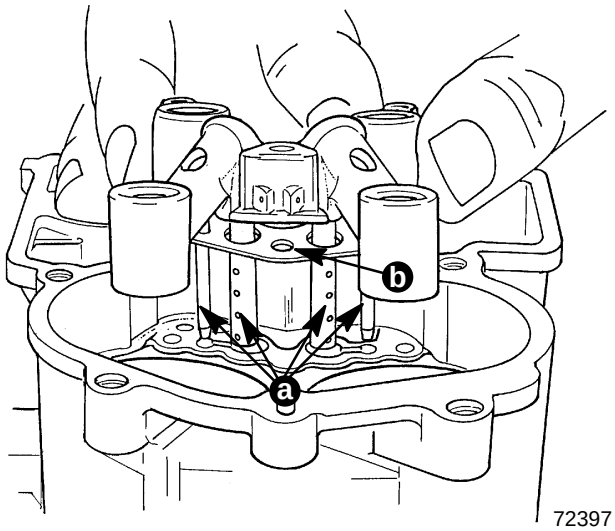
2. Install new gasket on venturi cluster as shown.



72296

a - Venturi Cluster (I.D. No. 421)
b - Gasket

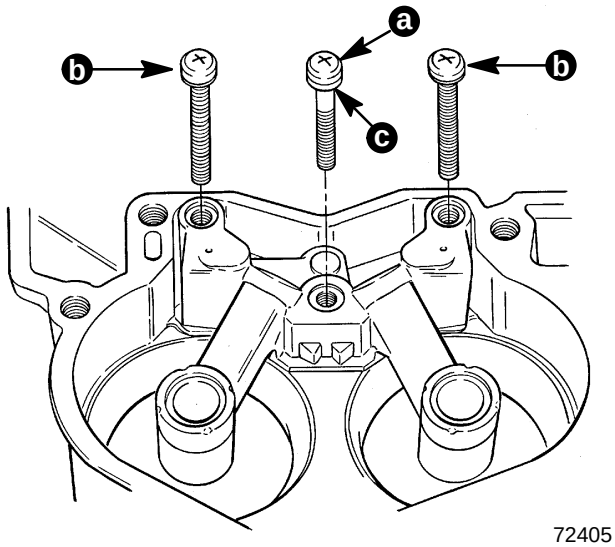
3. Install venturi cluster in carburetor as shown.



72397

a - Venturi Cluster
b - Gasket

4. Install flat washer and new fiber washer on center screw. Lockwashers and flat washers are used on outer screws. Tighten screws evenly and securely.

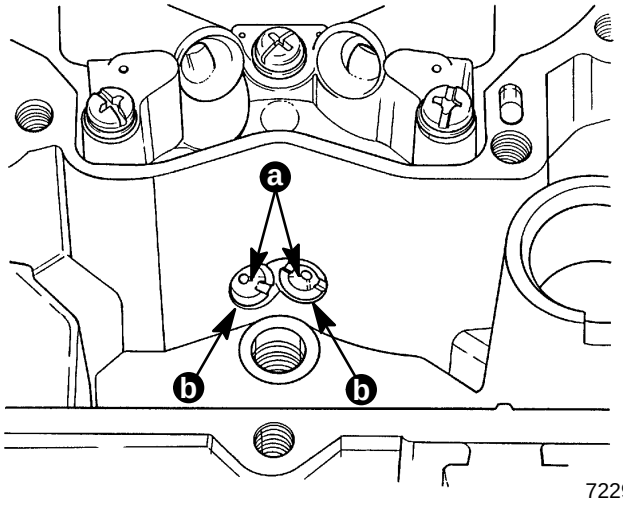


72405

a - Center Screw
b - Outside Screws
c - Fiber Washer

Index

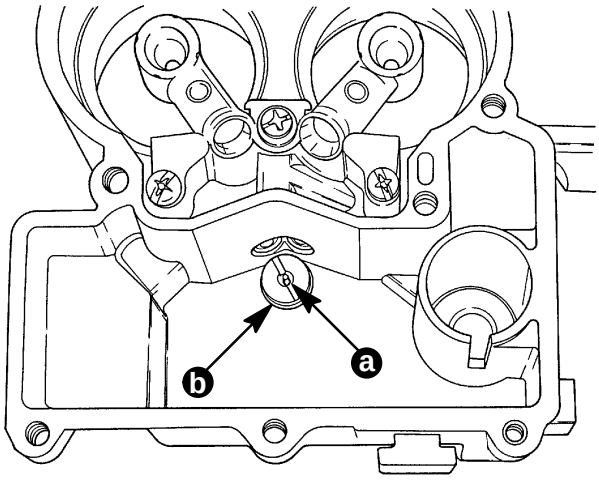
5. Install main metering jets with gaskets as shown. Tighten securely.



72291

a - Main Metering Jets
b - Gaskets (Not Shown)

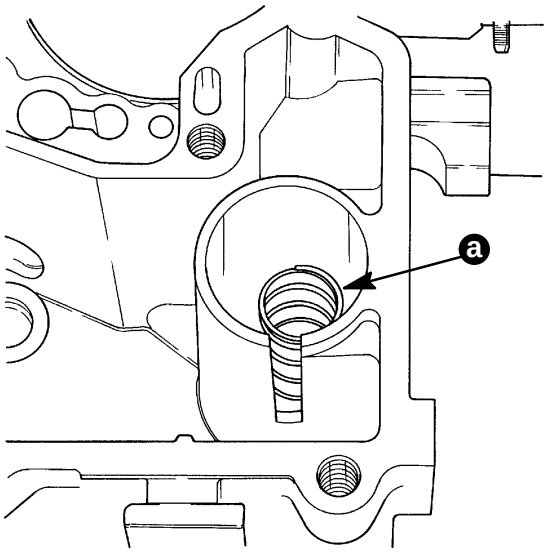
6. Install power valve with new gasket. Tighten securely.



72404

a - Power Valve
b - Gasket (Not Shown)

7. Place accelerator pump spring in pump well.



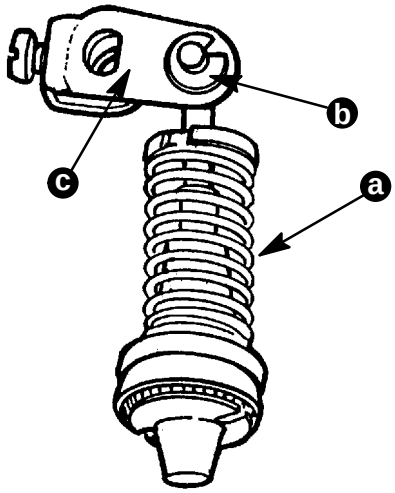
72402

a - Accelerator Pump Spring

AIR HORN ASSEMBLY

IMPORTANT: Accelerator pump assembly MUST BE installed correctly. If pump assembly is installed incorrectly, top of pump assembly will contact air horn casting.

1. If accelerator pump assembly was removed from pump lever, secure pump assembly to pump lever with washer and retainer clip, as shown.

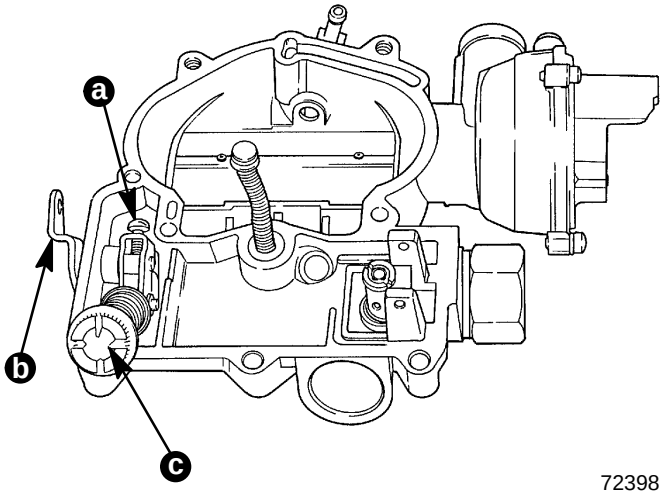


72409

a - Pump Assembly
b - Retainer Clip
c - Pump Lever

Index

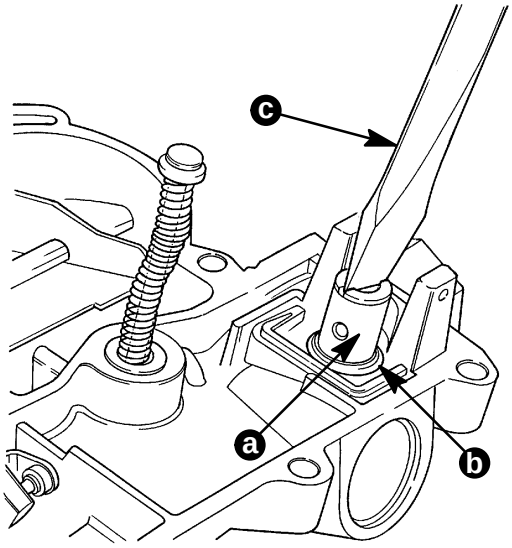
2. Insert pump shaft and lever assembly (and washer) into air horn; then, align indexed hole in pump lever with shaft and lever assembly and slide shaft all the way into lever so that shoulder on shaft is hitting lever. Tighten setscrew securely.



72398

a - Setscrew
b - Lever Assembly
c - Pump Assembly

3. Install needle seat and gasket. Tighten securely.

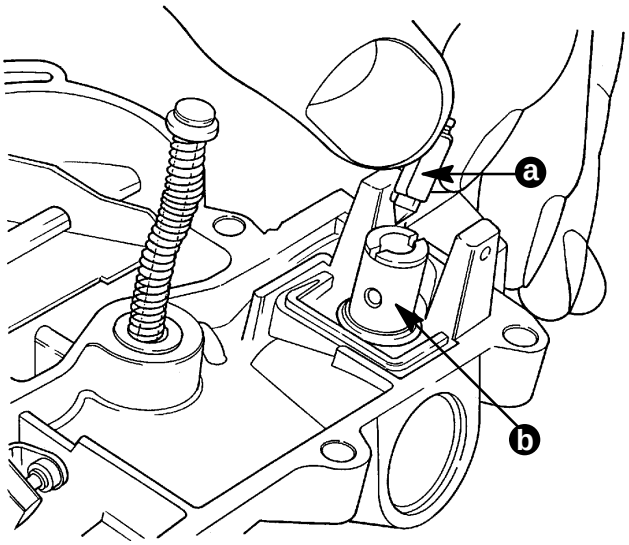


72289

a - Needle Seat
b - Gasket
c - Screwdriver

IMPORTANT: Float needle and needle seat are factory matched and tested and should be replaced as a set only.

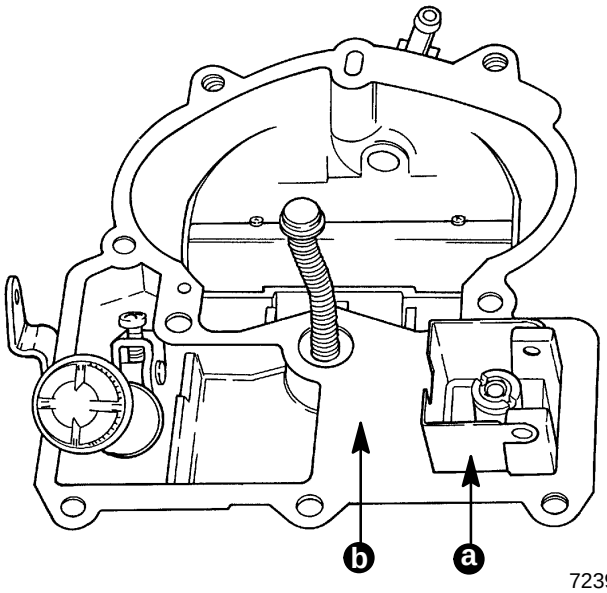
4. Place needle assembly in needle seat.



72287

a - Needle Assembly
b - Needle Seat

5. Install baffle and gasket.

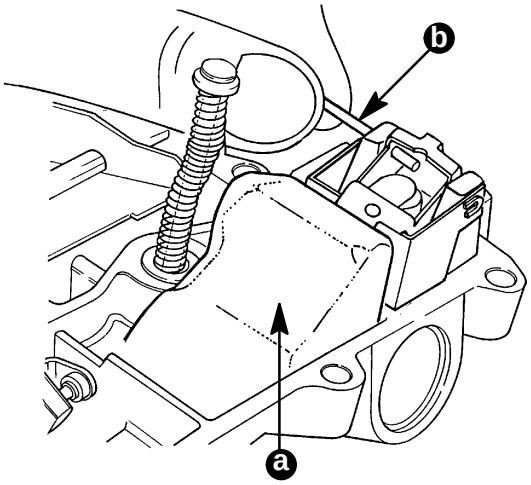


72399

a - Baffle
b - Gasket

Index

6. Install float assembly and hinge pin. Pivot float assembly up and down on hinge pin to ensure it moves freely.



72297

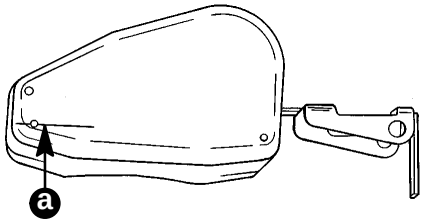
a - Float Assembly
b - Float Hinge Pin

FLOAT LEVEL

1. Turn air horn upside down. Pivot float assembly up and down on hinge pin to ensure it moves freely.

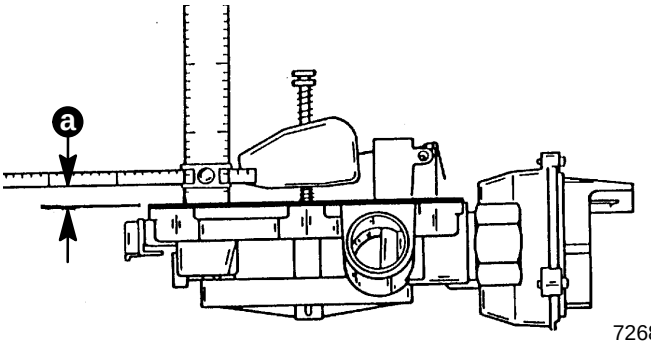
IMPORTANT: Before checking float level, raise float and allow it to fall; however, DO NOT force downward by hand.

2. Measure float level using Universal Carburetor Gauge (91-36392). Measure from gasket to toe of float.



72298

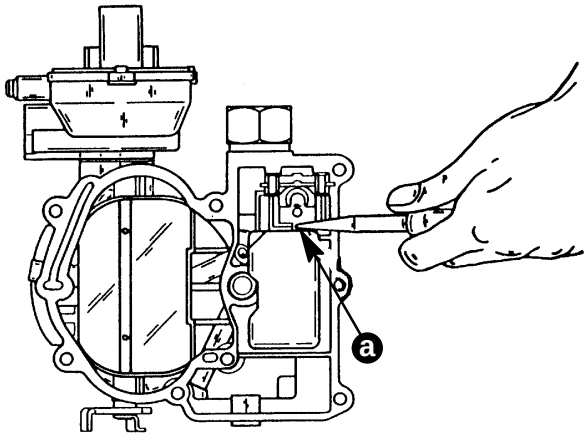
a - Measure from This Point to Gasket



72687

a - Measurement With 2 Piece Solid Inlet Needle - 3/8 in. (10 mm)
Measurement With Spring Loaded Inlet Needle - 9/16 in. (14 mm)

3. Bend float arm up or down at point shown to obtain specified dimension.



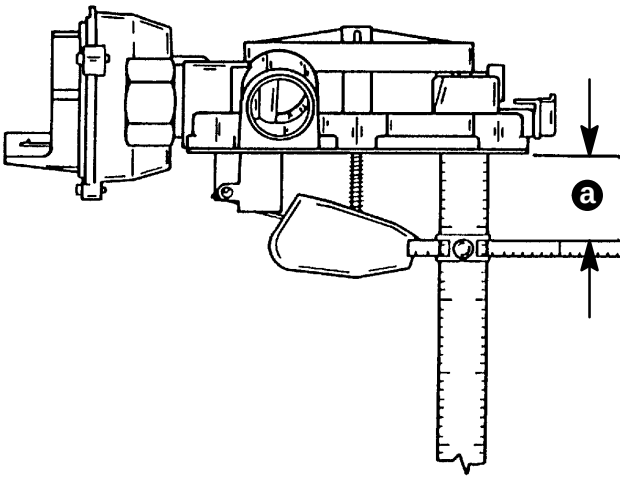
72688

a - Bend Float Arm at This Point

4. Visually check float alignment after adjustment.

FLOAT DROP

1. Hold air horn right side up to allow float to hang free.
2. Measure float drop using Universal Carburetor Gauge (91-36392). Measure from gasket to toe of float.

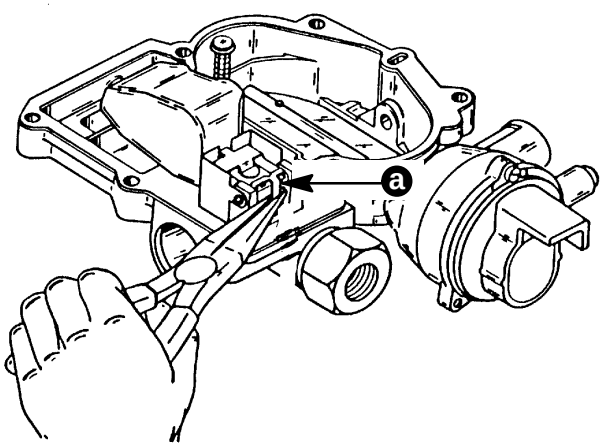


72689

a - Measurement - 1-3/32 in. (27 mm)

Index

3. Bend float assembly tang, as shown, to obtain specified dimension.

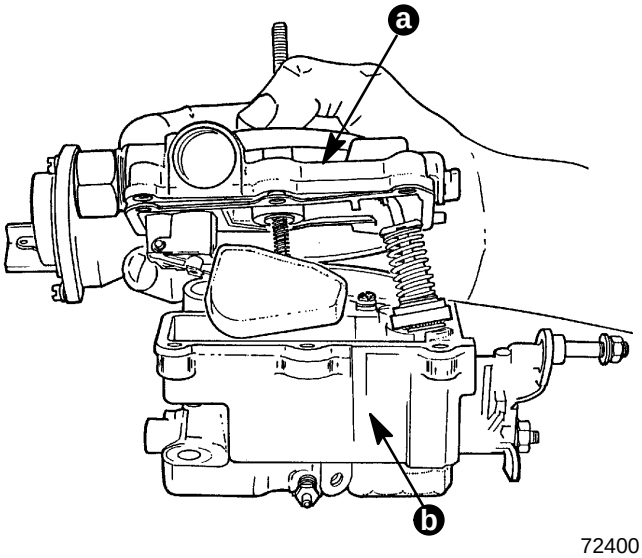


72690

a - Float Assembly Tang

4. Recheck BOTH float level and float drop.

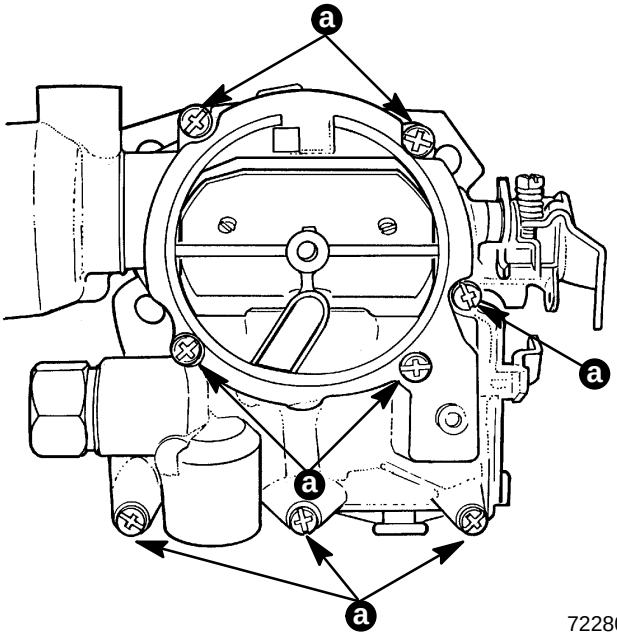
5. Carefully place air horn on float bowl, making sure accelerator pump is correctly positioned in fuel well. Lower air horn straight down to install.



72400

a - Air Horn Assembly
b - Float Bowl Assembly

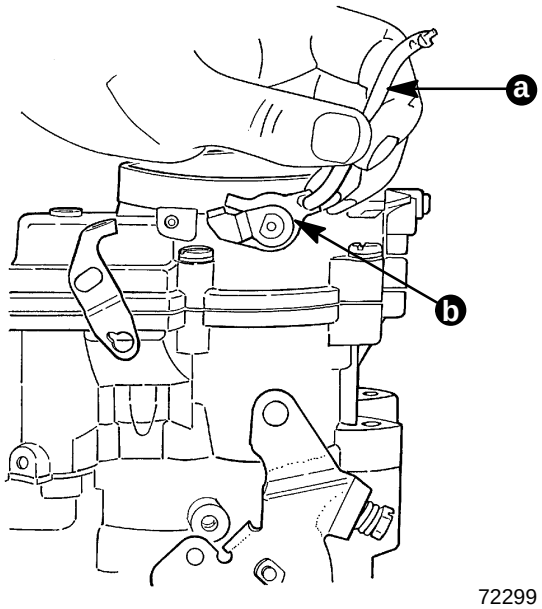
6. Install seven short and one long air horn attaching screws. Tighten screws evenly and securely.



72280

a - Air Horn Attaching Screws

7. Place end of choke rod in choke lever and collar assembly.

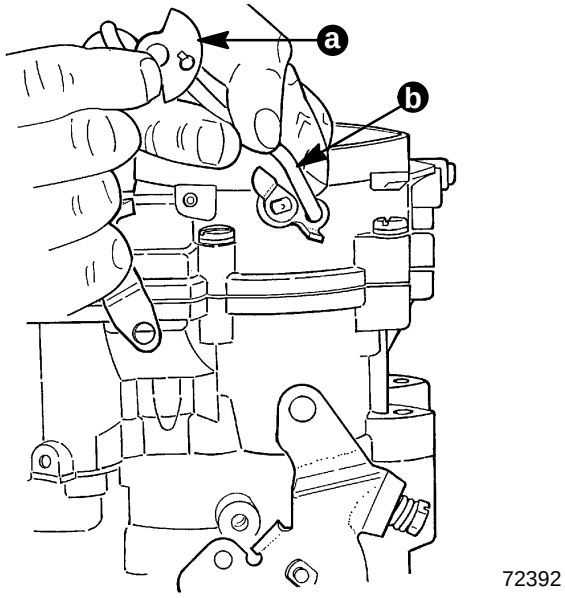


72299

a - Choke Rod
b - Choke Lever and Collar Assembly

Index

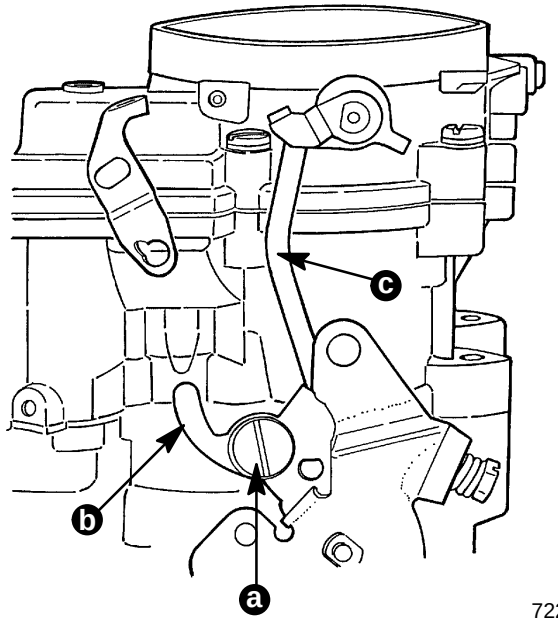
8. Place idle cam on choke rod.



72392

a - Idle Cam
b - Choke Rod

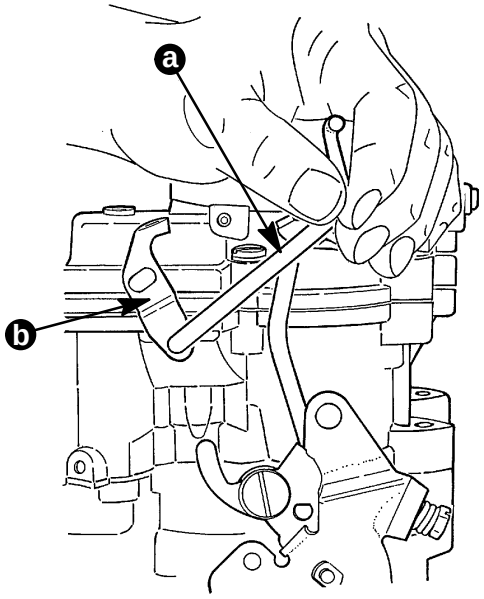
9. Secure idle cam (with choke rod installed on cam) on float bowl assembly, using screw. Check that cam is free to move without binding.



72282

a - Screw
b - Idle Cam
c - Choke Rod

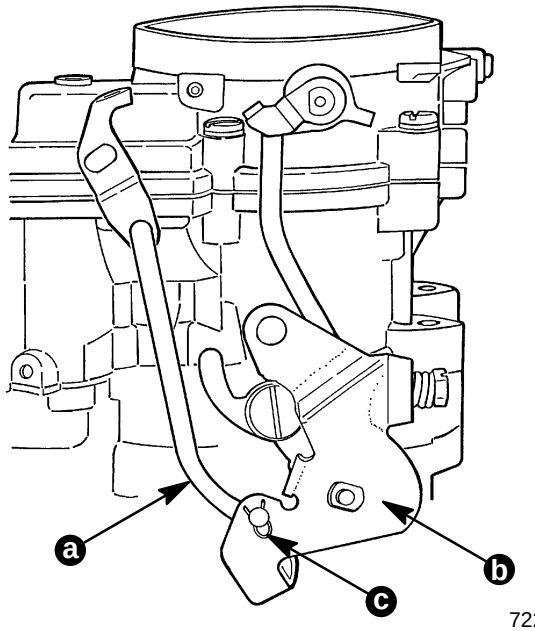
10. Place accelerator pump rod (end with ear) in hole in pump shaft and lever assembly.



72393

a - Accelerator Pump Rod
b - Pump Shaft and Lever Assembly

11. Insert remaining end of accelerator pump rod into hole in throttle lever and secure with retainer clip.



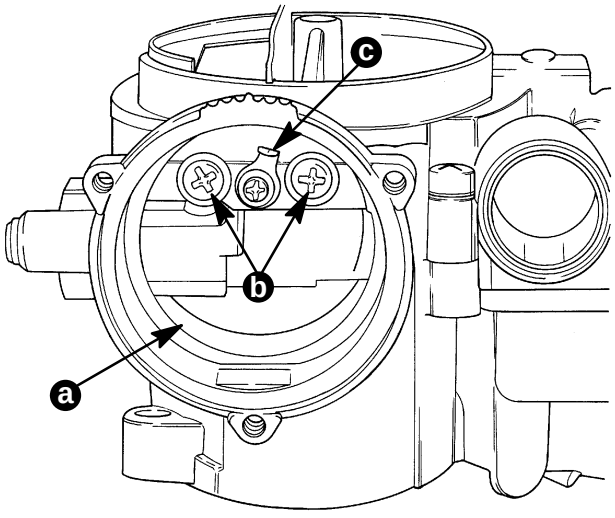
72283

a - Accelerator Pump Rod
b - Throttle Lever
c - Retainer Clip

Index

CHOKE HOUSING ASSEMBLY

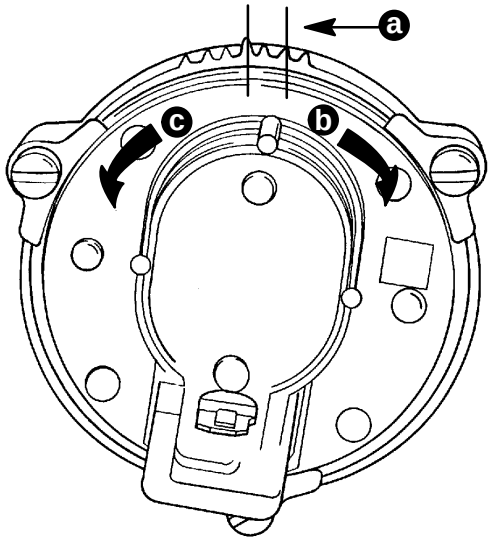
1. Install choke housing on air horn; tighten screws securely. Install choke lever; tighten screw securely.



72401

a - Choke Housing
b - Choke Housing Attaching Screws
c - Choke Lever

2. Install choke cover. Make sure hook on end of choke coil engages with choke lever. Rotate choke cover until index marks align as shown. Tighten screws securely.

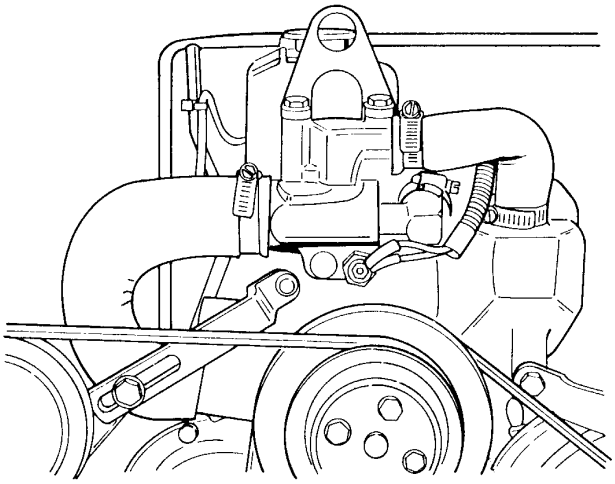


72403

a - Scribed Mark
b - More Choke
c - Less Choke

Index

COOLING SYSTEM



50628

SEAWATER COOLED MODELS

6

A

Index

Table of Contents

	Page
Torque Specifications	6A - 1
Tools/Lubricants/Sealants	6A - 1
Specifications	6A - 1
Flush Cooling System	6A - 1
Stern Drive Seawater Pickup Pump	6A - 2
Thermostat	6A - 2
Removal	6A - 2
Testing	6A - 2
Installation	6A - 3
Cold Weather Or Extended Storage	6A - 4
Auxiliary Hot Water Heater Installation	6A - 5
Cooling System Flow Diagram	6A - 7

NOTICE

For information and procedures on troubleshooting, refer to SECTION 1C.

NOTICE

For cold weather or extended storage information and procedures, refer to SECTION 1B.

Torque Specifications

Description	lb. ft.	N·m
Power Steering Pump Bracket	30	41
Thermostat Cover	30	41
Thermostat Housing	30	41
Water Circulating Pump	30	41
Water Temperature Sender	20	27
Water Temperature Switch	Tighten Securely	
Drain Plugs (Note 1)		
Petcocks		
Pulleys		
Hose Clamps		
Throttle Lever Nut to Throttle Body Shaft		

NOTE 1 Coat threads with Quicksilver Perfect Seal before installing.

Tools/Lubricants/Sealants

Description	Part Number
Universal Plate Puller	91-37241
Quicksilver Loctite 8831	92-823089-1
Quicksilver Perfect Seal	92-34227-1
Quicksilver 2-C-4 Marine Lubricant With Teflon	92-825407A3
Quicksilver Special Lubricant 101	92-13872A1
Flush Device	73971A2
Shell Alvania No. 2	Obtain Locally

Specifications

Cooling System Capacity	9 (8.5)
Thermostat (Brass)	143°F(62°C)

Flush Cooling System

If engine is operated in salty, polluted or mineral laden waters, cooling system should be flushed periodically (preferably after each use) to reduce corrosion and prevent the accumulation of deposits in the system. Cooling system also should be thoroughly flushed prior to storage.

⚠WARNING

When flushing cooling system with boat out of water, be certain that area in vicinity of propeller is clear and no one is standing nearby.

⚠CAUTION

Observe temperature gauge on dash to ensure that engine does not overheat.

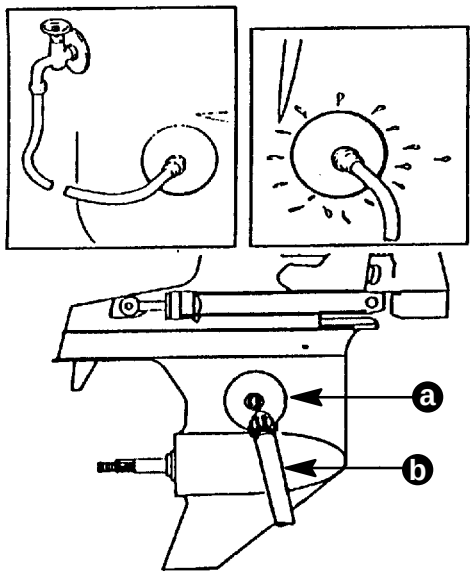
IMPORTANT: DO NOT run engine above 1500 RPM, as suction is created by seawater pick up pump may collapse water supply hose and cause engine to overheat.

IMPORTANT: If cooling system is to be flushed with the boat in the water, water inlet valve (if so equipped) must be closed, or water inlet hose must be disconnected and plugged to prevent water from flowing into boat.

IMPORTANT: If boat is in the water, DO NOT open water inlet valve until engine is restarted, to prevent contaminated water from flowing back into engine .

Index

Stern Drive Seawater Pickup Pump



72672

a - Flush Device
b - Garden Hose

1. Install flush device and connect garden hose between it and water tap.
2. Saltwater areas and boat in the water:
   a. Raise stern drive unit to full trailer position.
   b. Install flush device over water intake holes.
   c. Lower stern drive unit to full down position.
3. Partially open water tap (approximately 1/2 maximum capacity) and allow cooling system to fill completely. DO NOT use full water tap pressure.

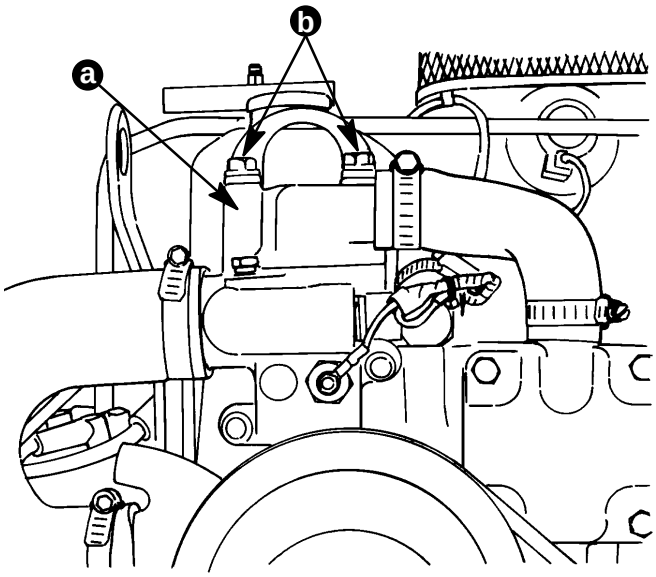
IMPORTANT: DO NOT run engine above 1500 RPM, as suction is created by seawater pick up pump may collapse water supply hose and cause engine to overheat.

4. Place remote control in NEUTRAL, idle speed position and start engine. Operate engine at idle speed, in NEUTRAL, for about 10 minutes, or until discharge water is clear. Watch temperature gauge on instrument panel to ensure that engine does not overheat.
5. Stop engine, turn off water tap and remove flush device.

Thermostat

Removal

1. Drain water from cylinder block and exhaust manifold.
2. Disconnect Hose from thermostat cover.
3. Remove thermostat cover attaching bolts and lock-washers, then remove and screws.
4. Remove thermostat from thermostat housing or cover.



73572

a - Thermostat Cover
b - Attaching Bolts

Testing

1. Clean thermostat in soap and water to remove any deposits or debris.
2. Inspect for corrosion or other visible damage.
3. If thermostat is suspected of producing insufficient engine temperature, check thermostat for leakage by holding it up to a lighted background. Light leakage around the thermostat valve indicates that thermostat is not closing completely and should be replaced. (A small amount of leakage one or two locations around the valve perimeter is acceptable.)

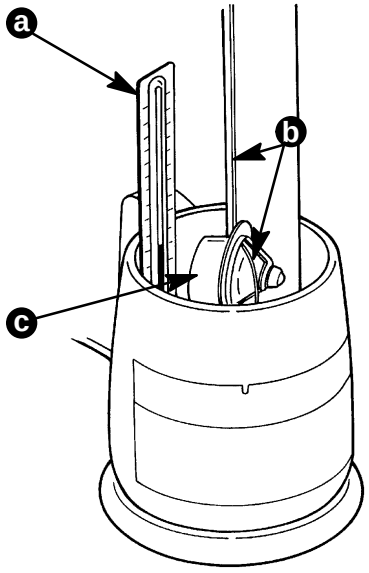
Index

4. Check opening and closing temperature of the thermostat (using a tester similar to one shown below), as follows

   a. Fill tester to within 1 inch (25 mm) of top with tap water. DO NOT use distilled water.

   b. Open thermostat valve and insert nylon string. Position thermostat on string so that it will be just below water level when suspended, then allow valve to close. Suspend thermostat in water.

   c. Place thermometer in container and position so that bottom of thermometer is even with bottom of thermostat. DO NOT allow thermometer to touch container.



72675

a - Thermometer
b - Nylon String
c - Thermostat

IMPORTANT: When performing step d thru f, water must be thoroughly agitated to obtain accurate results.

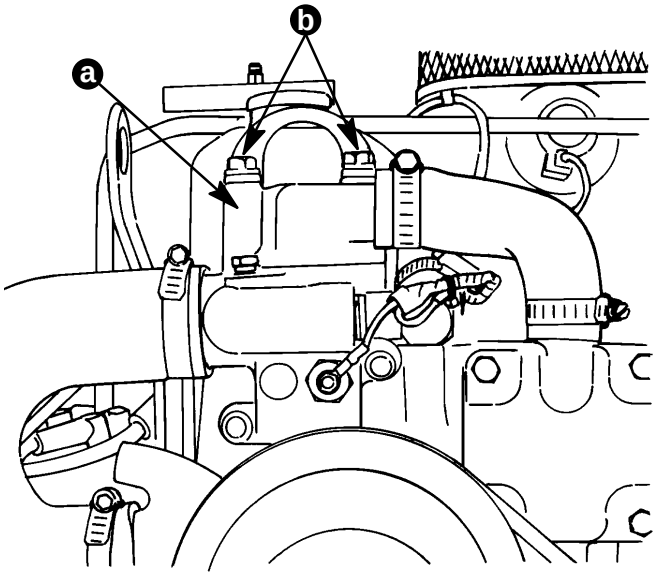
   d. Plug in tester and observe temperature at which thermostat opens (thermostat drops off thread). Thermostat must open at specified temperature stamped on thermostat.

   e. Continue heat water until a temperature 25° F (14 ° C) above temperature specified on thermostat valve must be completely open at this temperature.

   f. Replace a thermostat that fails to meet all of the preceding tests.

Installation

1. Clean gasket surfaces on thermostat cover and thermostat housing.
2. Place thermostat in thermostat housing with thermostatic element end toward housing. Be sure to position thermostat so that mounting flange fits into recess in thermostat housing.
3. Coat both sides of new thermostat housing gasket with Quicksilver Perfect Seal and position on thermostat cover and torque bolts to 30 lb. ft. (41 N·m)



73572

a - Thermostat Cover
b - Attaching Bolts

4. Reconnect hose to thermostat cover.
5. Start engine and inspect for leaks.

Index

Cold Weather Or Extended Storage

⚠ CAUTION

Cooling system must be completely drained for storage, or trapped water may cause freeze and/or corrosion damage to engine.

⚠ CAUTION

If boat is in the water, seacock (water inlet valve), if so equipped, must be left closed until engine is to be restarted to prevent water from flowing back into cooling system and/or boat. If boat is not fitted with a seacock, water inlet hose must be left disconnected and plugged to prevent water from flowing back into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel of the boat with the warning that the seacock must be opened or the water inlet hose reconnected prior to starting the engine.

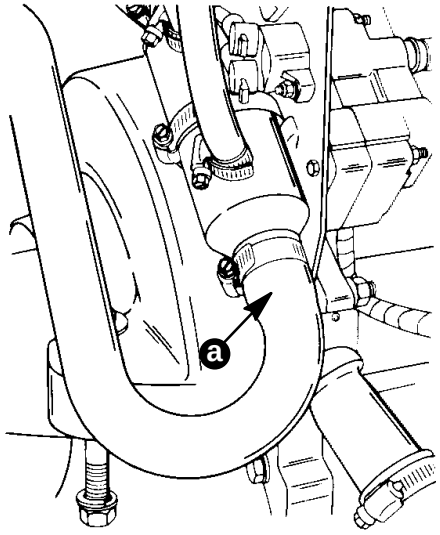
IMPORTANT: Observe the following information to ensure complete draining of cooling system.

- **Engine must be as level as possible.**
- **A wire should be repeatedly inserted into all drain holes to ensure there are no obstructions in passages.**

IMPORTANT: To prevent threads in manifolds, elbows and cylinder blocks from rusting out during storage, reinstall plugs using Quicksilver Perfect Seal on threads. Never leave drain plugs out during storage.

NOTE: If possible, place a container under drains and hoses to prevent water from draining into boat.

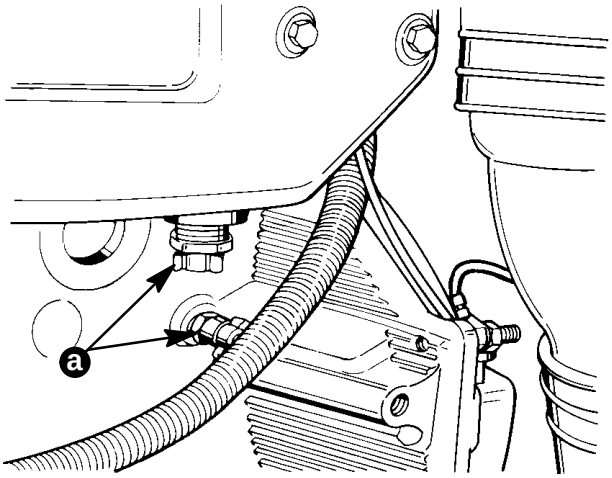
1. Engine must be level or front of engine slightly higher to properly drain cooling system.
2. Remove hose from power steering cooler.



71422

a - Raw Water Hose to Power Steering Cooler

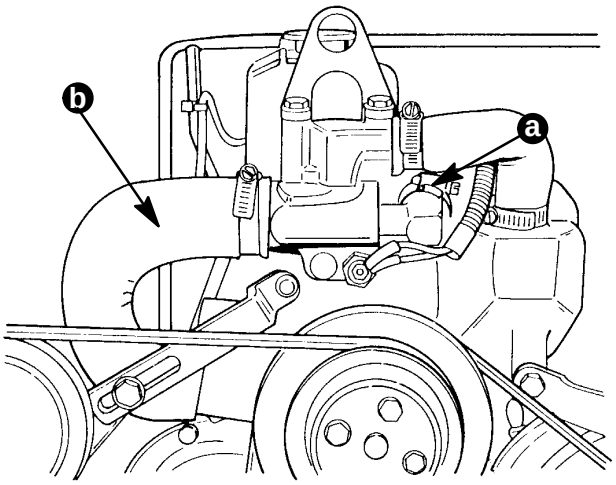
3. Remove drain plugs from port side of cylinder block and exhaust manifold.



71424

a - Drain Plugs

4. Remove and lower hoses to allow them to drain.

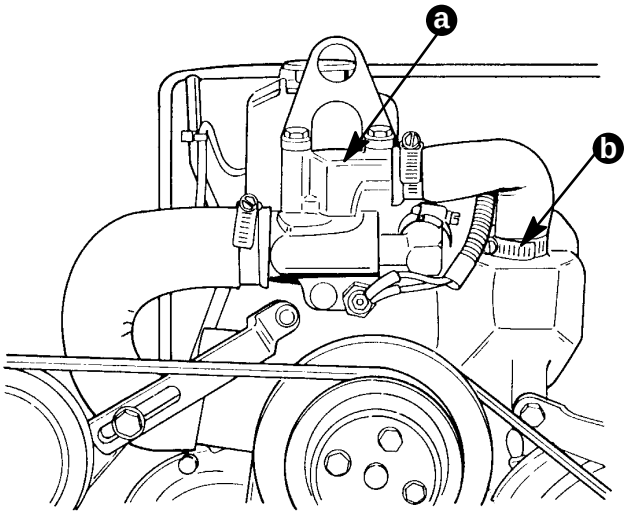


50628

a - Inlet Hose
b - Circulating Pump Hose

5. After cooling system has drained completely, coat threads of drain plugs with Perfect Seal and reinstall.

NOTE: For additional assurance against freezing and rust, fill the cooling system with a solution of anti-freeze and water (mixed to proportions recommended by manufacturer for lowest temperature to which engine will be exposed during storage).



50628

a - Thermostat Housing
b - Hose

6. Remove thermostat housing and fill with coolant until block and head is full. Install thermostat housing with new gasket. Torque to 30 lb. ft. (41 N·m).
7. Remove water hose from exhaust manifold and fill manifold with coolant. Install hose and tighten clamp securely.

Auxiliary Hot Water Heater Installation

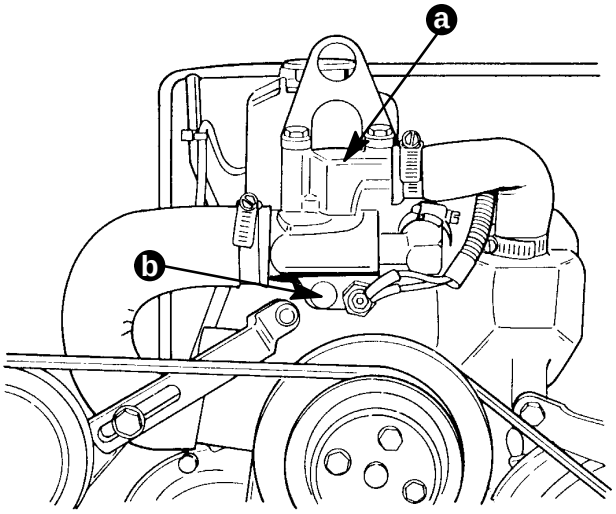
When connecting a cabin heater or hot water heater to a MerCruiser engine, certain requirements must be met.

- **Supply hose (from engine to heater) and return hose (from heater to engine) MUST NOT EXCEED 5/8 in. (15.8 mm) I.D. (inside diameter).**
- **Make heater connections ONLY at locations described in the following instructions.**
- **Check complete system for leaks after heater is connected into cooling system.**
- **Check for overheating condition (of engine) after heater is connected.**

An auxiliary hot water heater kit is not available from Mercury Marine for this model MerCruiser engine. To connect a cabin heater or hot water heater to these engines, use the following procedure:

1. Drain water from cooling system.

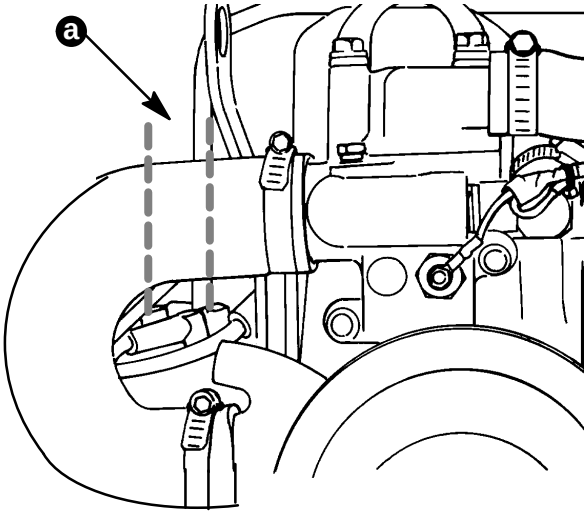
2. Remove plug for thermostat housing at location shown.



50628

a - Thermostat Housing
b - Plug

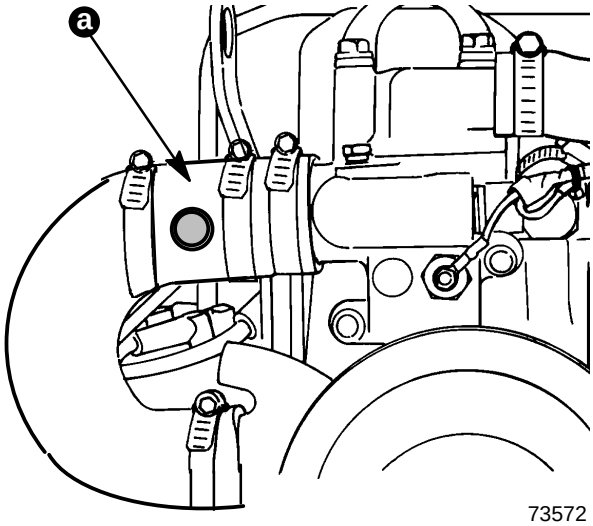
3. Cut hose for return fitting as shown below. Cut approximately 3/4 in. (19 mm) out of hose to maintain proper hose configuration.



73572

a - Cut Hose at This Location

4. Install return fitting in hose and tighten hose clamps securely.



73572

a - Return Fitting

5. Connect hot water return hose to return fitting and tighten hose clamps securely.

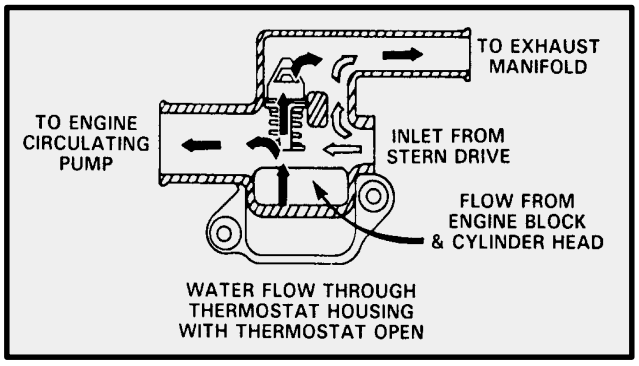
6. Ensure that hoses do not rub or chafe against any engine components.

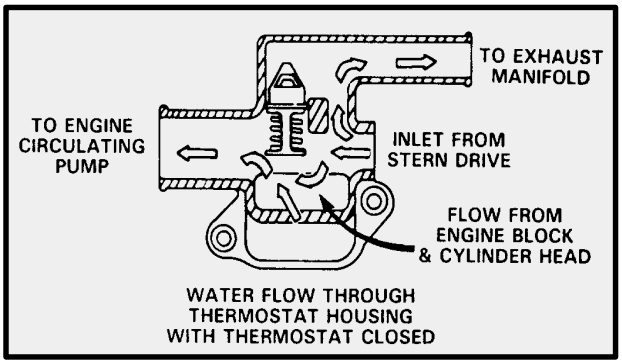
Index

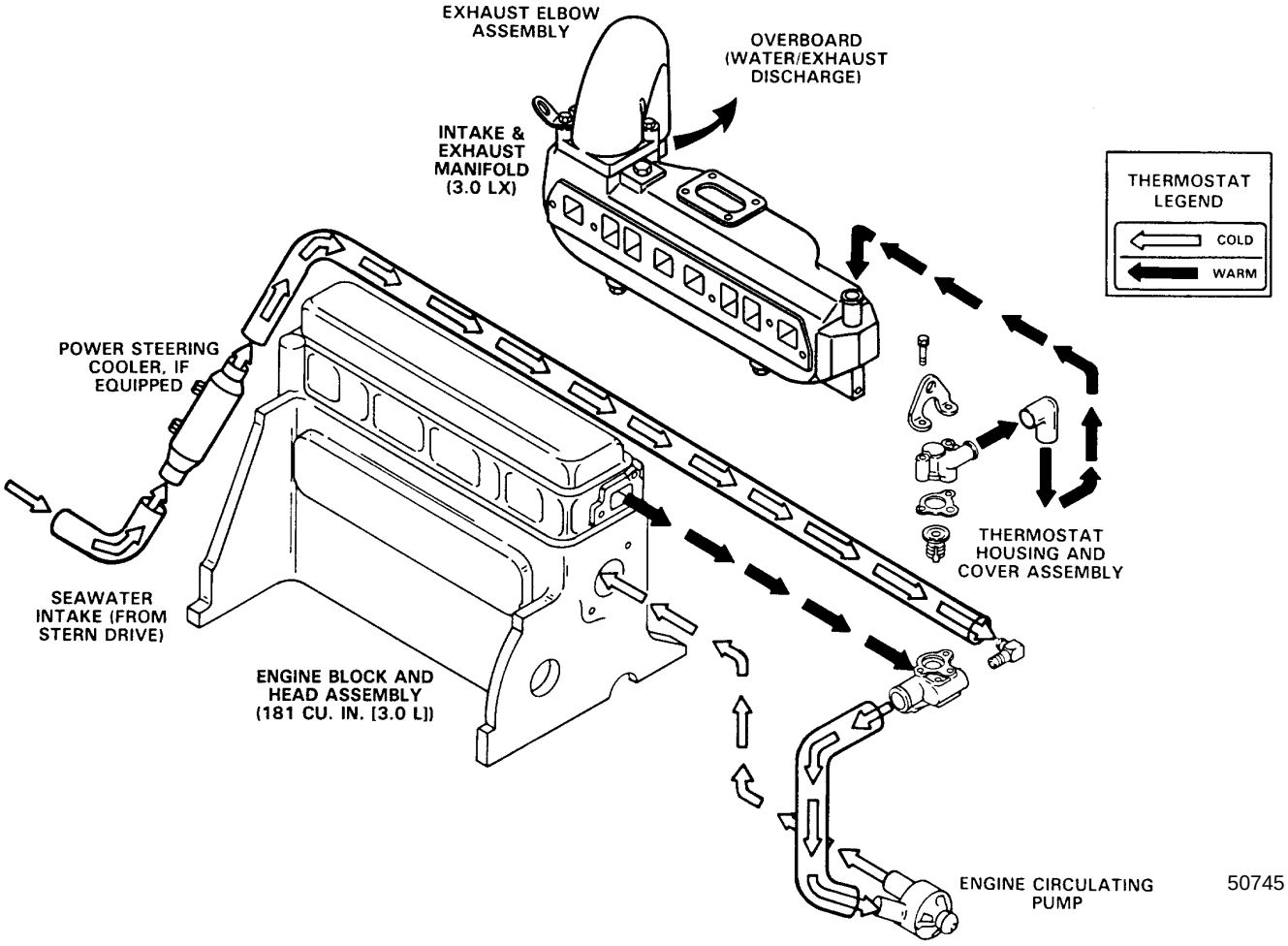
Cooling System Flow Diagram

MerCruiser engines with standard cooling systems use seawater (water in which the boat is being operated), to remove the heat given off by the engine.

The seawater is pumped to the cooling system by means of an impeller type pickup pump (located in the vertical drive) which picks up seawater, and delivers it to the centrifugal pump (located over an opening on the front of the cylinder block). On some models seawater may be pumped through an oil cooler before going to the circulating pump. The centrifugal pump then circulates the seawater through the block, head and manifolds, removing heat given off by these parts as it passes through. After passing through the engine, the seawater is pumped into the exhaust elbow where it mixes with exhaust gases and then is expelled overboard. A thermostatic heat control, which controls circulation of seawater, also is incorporated into the system. It provides fast engine warm-up and controlled operating temperature.

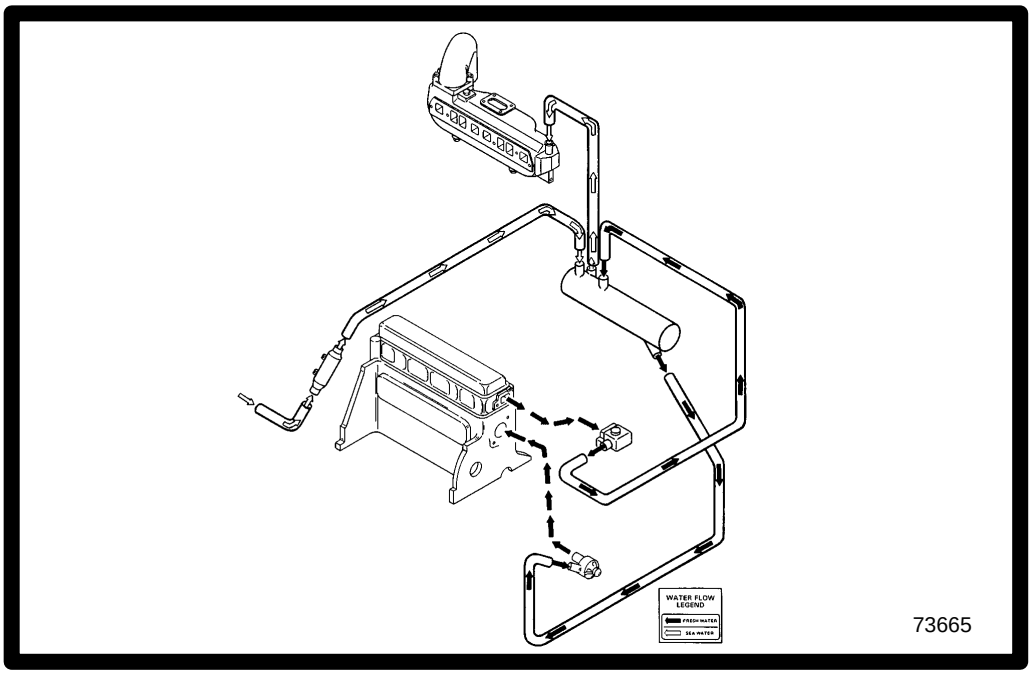






Index

COOLING SYSTEM



CLOSED COOLING MODELS

6

B

Index

Table of Contents

	Page
Torque Specifications	6B - 1
Lubricants/Sealants	6B - 1
Specifications	6B - 1
Description	6B - 1
Pressure Cap Maintenance	6B - 2
Heat Exchanger Repair	6B - 2
Testing Closed Cooling System	6B - 3
Testing Coolant for Alkalinity	6B - 3
Pressure Testing System	6B - 3
Testing for Cylinder Head Gasket Leak	6B - 4
Testing Heat Exchanger	6B - 4
Testing Pressure Cap	6B - 5
Thermostat	6B - 6
Removal	6B - 6
Testing	6B - 6
Installation	6B - 7
Changing Coolant	6B - 7
Closed Cooling Section	6B - 8
Coolant Recommendations	6B - 8
Change Intervals	6B - 8
Draining Instructions	6B - 8
Draining Diagram	6B - 9
Cleaning System	6B - 10
Closed Cooling Section	6B - 10
Seawater Section	6B - 10
Flushing Seawater Section of Closed Cooling System	6B - 11
Draining Seawater Section of Closed Cooling System	6B - 12
Recommissioning	6B - 13
Filling Closed Cooling Section	6B - 14

NOTICE

For information and procedures on trouble-shooting, refer to SECTION 1C.

NOTICE

For cold weather or extended storage information and procedures, refer to SECTION 1B.

Index

Torque Specifications

Description	lb. in.	lb. ft.	N·m
Drain Plugs	Securely		
Heat Exchanger End Caps	190		22
Reservoir to Thermostat Housing		30	41
Thermostat Cover		20	27
Hose Clamps	Securely		
Heat Exchanger Mounting Brackets			

Lubricants/Sealants

Description	Part Number
Quicksilver 2-C-4 Marine Lubricant With Teflon	92-825407A3
Quicksilver Perfect Seal	92-34227-1

Specifications

Cooling System Capacity	9 (8.5)
Thermostat	143°F(62°C)
Cap Pressure	14 PSI (97 kPa)

Description

There are several configurations of this cooling system, but the operation is essentially identical. Basically, the system is composed of two separate subsystems: the seawater system and the closed cooling system. The seawater system is similar in function to the fan used in an automobile because it absorbs heat (from the closed cooling system) as it passes through the heat exchanger. The closed cooling system is similar in function to the rest of the cooling system in an automobile.

The coolant recovery system keeps the reservoir full. Normal coolant overflow into recovery bottle is approximately 1/2 pint (230 ml) during warm-up. The coolant recovery system draws coolant back into the reservoir from the recovery bottle as the engine cools. As long as there is coolant in the recovery bottle, the reservoir should remain completely full. If not, there's a vacuum leak, usually at the hose leaving the reservoir, or the gasket under the recovery filler cap. The gasket seals against the outer rim of the filler neck.

IMPORTANT: The coolant (antifreeze) flows around the outside of the cooling tubes while seawater flows through the inside of the cooling tubes in the heat exchanger.

Engine exhaust manifold is seawater cooled. Stern drive seawater pickup pumps seawater thru the heat exchanger.

Coolant Recovery Bottle

Before starting engine each day, check to ensure that coolant is visible in coolant recovery bottle.

If coolant is not visible, check fresh water section of cooling system (including coolant recovery system) for leaks and repair, as necessary. Refill fresh water section with recommended coolant solution, as outlined under "Changing Coolant," following.

If coolant is visible, start engine and run until it reaches normal operating temperature, then recheck coolant level in coolant recovery bottle. Coolant level MUST BE between the ADD and FULL marks (on front of bottle).

⚠ WARNING

Allow engine to cool before removing pressure cap, as sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

If level is low, remove fill cap from coolant recovery bottle and add required amount of coolant solution. Use a 50/50 mixture of ethylene glycol antifreeze and pure, soft water for coolant additions. If frequent additions of coolant are required, check fresh water section for leaks.

IMPORTANT: ALCOHOL OR METHANOL BASE ANTIFREEZE OR PLAIN WATER ARE NOT RECOMMENDED FOR USE IN COOLING SYSTEM AT ANY TIME. In areas where ethylene glycol is not available, and the possibility of freezing does not exist, it is permissible to use a solution of rust inhibitor and pure, soft water (mixed to manufacturer's recommendations).

Occasionally, check to ensure that coolant recovery system is functioning properly by removing pressure cap from heat exchanger and checking level. Coolant level should be up to bottom of heat exchanger filler neck. If low, examine entire fresh water section (especially coolant recovery system) for leaks and repair, if necessary.

IMPORTANT: When reinstalling pressure cap, be sure to tighten it until it contacts stops on filler neck.

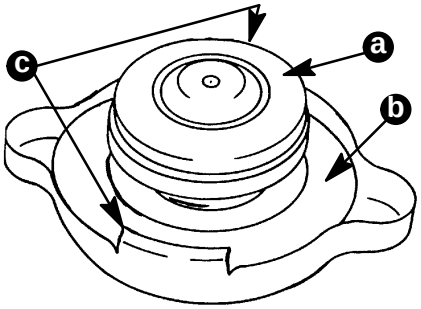
Pressure Cap Maintenance

Pressure cap is designed to maintain pressure in fresh water section of closed cooling system once the engine has attained normal operating temperature. This raises the boiling point of the coolant, thereby increasing the efficiency of the cooling system. To help ensure proper operation, cap should be cleaned, inspected and pressure tested periodically as follows:

⚠WARNING

Allow engine to cool before removing pressure cap (in next step), as sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

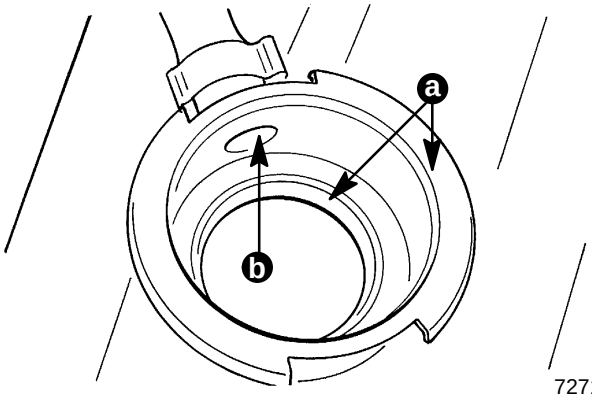
1. Remove pressure cap from heat exchanger.
2. Wash cap with clean water to remove any deposits or debris from sealing surfaces.
3. Inspect rubber seal on cap for cuts, cracks or other signs of deterioration. If seal is damaged, cap MUST BE replaced.
4. Inspect coolant recovery gasket for deterioration and replace if bad.
5. Check condition of locking tabs on cap. Replace cap if tabs are bent or cracked.



72714

a - Rubber Seal (Cap MUST BE Replaced if Damaged)
b - Gasket (Look for Cracks under Gasket)
c - Locking Tabs (1 Hidden)

6. Refer to "Testing Pressure Cap" and test pressure cap as outlined.
7. Clean sealing surfaces on heat exchanger filler neck with a cloth. Inspect surfaces for any damage or deposits that may prevent cap from sealing properly.
8. Clean coolant recovery passage in heat exchanger filler neck with a wire and blow out with compressed air.



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a - Inspect for Damage
b - Clean Coolant Recovery Passages

9. Reinstall pressure cap, being sure to tighten until it contacts stops on filler neck.

Heat Exchanger Repair

IMPORTANT: Braze with BCUP 2 rod or silver solder. Care must be taken not to melt other joints during repair.

1. Internal leaks can be repaired by brazing shut the ends of the leaking tube. This is only a temporary fix because usually another tube will start leaking after a short period of time and this also causes a reduction in cooling capacity. Do not close more than three tubes.
2. Nipples and drains that hav ı broken off the heat exchanger can be rea d by brazing.

Index

Testing Closed Cooling System

Testing Coolant for Alkalinity

⚠WARNING

Allow engine to cool before removing pressure cap as sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

Coolant in fresh water section should be changed every two years and should be checked for alkalinity at least once between change intervals. To check coolant for alkalinity, proceed as follows:

1. Obtain pink litmus paper from a local supplier (drug store, pet shop, etc.).
2. Remove pressure cap from heat exchanger and insert one end of litmus paper into coolant.
3. **If pink litmus paper turns blue,** coolant is alkaline and need not be replaced.
4. **If pink litmus paper remains pink,** coolant is not alkaline and MUST BE REPLACED, as explained under “Changing Coolant.”

Pressure Testing System

⚠WARNING

Allow engine to cool before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

If coolant section of closed cooling system is suspected of leaking or not holding sufficient pressure, and no visible signs of leakage can be found, perform the following test:

1. Remove pressure cap from heat exchanger or reservoir.
2. Clean, inspect and pressure test pressure cap, as outlined under “Testing Pressure Cap,” to eliminate the possibility that cap is not maintaining proper pressure in system and is causing coolant to boil over.
3. Clean inside of filler neck to remove any deposits or debris. Examine lower inside sealing surface for nicks or other damage. Surface must be perfectly smooth to achieve a good seal between it and rubber seal on cap. Also check locking cams on sides of filler neck to be sure that they are not bent or damaged. If locking cams are bent or damaged, pressure cap will not hold the proper pressure.
4. Adjust coolant level in fresh water section to 1 in. (25 mm) below filler neck.
5. Attach an automotive-type cooling system pressure tester to filler neck and pressurize closed cooling section to amount specified in following chart, based on pressure cap rating for your engine.

Pressure Cap Rating	Amount of Pressure Applied to Closed Cooling System
14 PSI (97 kPa)	17 PSI (117 kPa)

6. Observe gauge reading for approximately two minutes; pressure should not drop during this time. If pressure drops, proceed with the following steps until leakage is found.
7. While maintaining specified pressure on closed cooling section, visually inspect external portion of cooling system (hoses, gaskets, drain plugs, petcocks, core plugs, circulating pump seal, etc.) for leakage. Also listen closely for bubbling or hissing, as they usually are a sure indication of a leak.
8. Refer to “Testing Heat Exchanger” in this section and test as outlined.
9. If no leakage could be found in above steps, engine is leaking internally, and it probably is due to one or more of the following: (1) loose cylinder head bolts or damaged gasket, (2) loose intake manifold bolts or damaged gasket, (3) loose exhaust elbow or distribution block retaining nuts or damaged gasket, (4) cracked or porous cylinder head or block, or (5) cracked or porous exhaust manifold. Proceed as follows until location of internal leak is found.

Index

a. Start engine. Re-pressurize system to previously specified amount and observe pressure gauge on tester. If needle in gauge vibrates, compression or combustion is leaking into closed cooling section from a leak in the combustion chamber. Exact cylinders, where leakage is taking place, sometimes can be found by removing spark plug wires (one at a time) while observing pressure gauge. Vibration will decrease or stop when plug wire is removed from leaking cylinder. Stop engine.

b. Remove spark plugs (one at a time) from cylinders and examine for presence of coolant. A spark plug that is perfectly clean or milky appearing is a sure indication of a leak.

c. Drain oil from engine and examine for presence of coolant. Oil usually will be milky if coolant is present. If coolant is present, remove engine from boat and drop the oil pan. With engine in the upright position, re-pressurize closed cooling section to previously specified amount and examine internal surfaces of engine to locate leak.

d. If no leakage can be found in above steps, entire engine must be disassembled and inspected for leakage.

Testing for Cylinder Head Gasket Leak

A leaking head gasket will cause combustion gas to be forced into the cooling system. The mixture of coolant and tiny air bubbles is a poor heat conductor and will overheat an engine quickly. Compression tests or cooling system pressure check normally will not detect the leak because the test pressure is far below the combustion pressures which cause the leak. An effective test is as follows:

IMPORTANT: Run boat in lake for this test. It is best to run the engine at or above cruising speed during this test. Usually a failed head gasket will not cause the engine to overheat below cruising speed.

1. Install a clear plastic hose between the reservoir and coolant recovery bottle. Use a 2-3 ft. (61-91 cm) long hose for this test.
2. Route this hose so a “U” is formed.
3. Put enough coolant into hose to fill the center 4 or 5 inches (10-13 cm) of the “U.”
4. Observe the “U” while the engine is running.

a. **During Idle and Warm-Up:** Some coolant and/or air will leave the reservoir.

b. **During Cruising Speed (2500-3500 RPM):** Coolant and/or air leaving the reservoir should stop after approximately five minutes running at a given RPM. A leaking head gasket will produce air bubbling through the “U,” going to the coolant recovery bottle. The frequency and size of the bubbles will depend on the size of the leak.

c. **At Higher Speeds (4000+ RPM):** Normal operation is the same as described in “b” above. A failed head gasket will cause the bubbles to come faster and may be accompanied by violent, intermittent bursts of coolant.

It is important not to confuse normal warm-up expansion with a failed head gasket. Normal warm-up produces an intermittent flow of coolant which will stop within approximately five minutes at a given RPM. A head gasket leak will not stop because the one thing that marks a failed head gasket is the continued passage of air. This may be accompanied by violent, intermittent bursts of coolant leaving the reservoir. If coolant continues to flow (not in violent, intermittent bursts) from the reservoir at cruising speed, something else besides the head gasket is causing the engine to overheat.

Testing Heat Exchanger

FOR INTERNAL LEAK: An internal leak will cause coolant to go into the seawater circuit when pressure is put on the closed cooling circuit.

1. Remove a seawater hose from the exchanger. Do not drain the exchanger.
2. Pressurize the closed cooling circuit to 14-20 PSI (97-138 kPa) with a radiator tester.
3. If seawater begins to flow from the nipple there is a leak.

FOR BLOCKAGE:

IMPORTANT: Seawater flows THROUGH the tubes in the exchanger. Closed cooling coolant flows AROUND the tubes.

1. Remove end caps and inspect for any blockage in the seawater circuit (broken impeller blades, weeds, etc.).

Index

2. Remove closed cooling circuit hoses and inspect the tubes just inside the nipples. Because the complete exchanger cannot be inspected, the heat exchanger should be replaced if blockage is suspected.

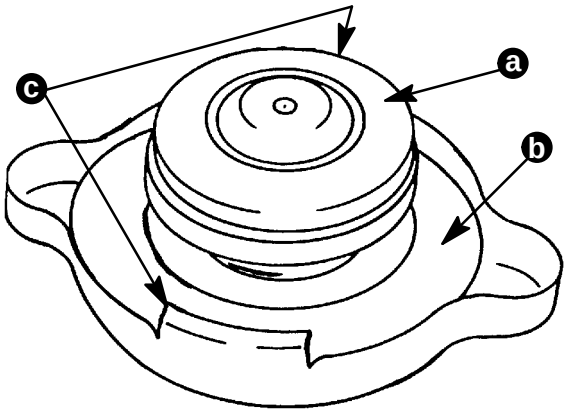
Testing Pressure Cap

Pressure cap is designed to maintain a pressure of approximately its rated capacity (refer to “Specifications”) in closed cooling section once engine has attained operating temperature. Cap should be cleaned, inspected and pressure-tested at regular tune-up intervals or whenever cap is suspected of maintaining improper pressure as follows:

⚠ WARNING

Allow engine to cool before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

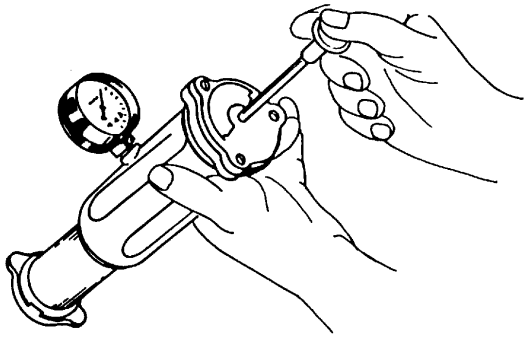
1. Carefully remove pressure cap from reservoir or heat exchanger.
2. Wash cap with clean water to remove any deposits or debris from sealing surfaces.
3. Inspect gasket (if used) and rubber seal on cap for tears, cuts, cracks or other signs of deterioration. Replace gasket, if damaged, or entire cap if rubber seal is damaged.



72714

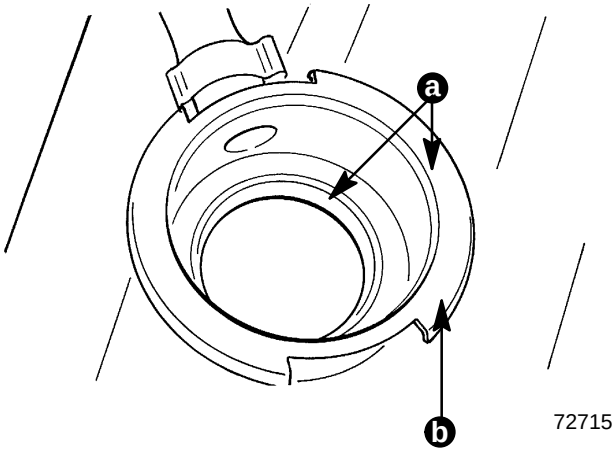
a - Rubber Seal (Cap MUST BE Replaced if Damaged)
b - Gasket (Look for Cracks under Gasket)
c - Locking Tabs (1 Hidden)

4. Check that locking tabs on cap are not bent or damaged.
5. Using a cooling system pressure tester (similar to one shown), test cap to be sure that it releases at proper pressure and does not leak. (Refer to instructions which accompany tester for correct test procedure.) Cap must relieve pressure at 14 PSI (97 kPa), and must hold rated pressure for 30 seconds without going below 11 PSI. Replace cap if it fails to fall within these limits.



72716

IMPORTANT: Before reinstalling cap in next step, examine lower inside sealing surface in filler neck to ensure that it is perfectly smooth and free of debris. Also, inspect cam lock flanges on sides of filler neck to be sure that they are not bent.



72715

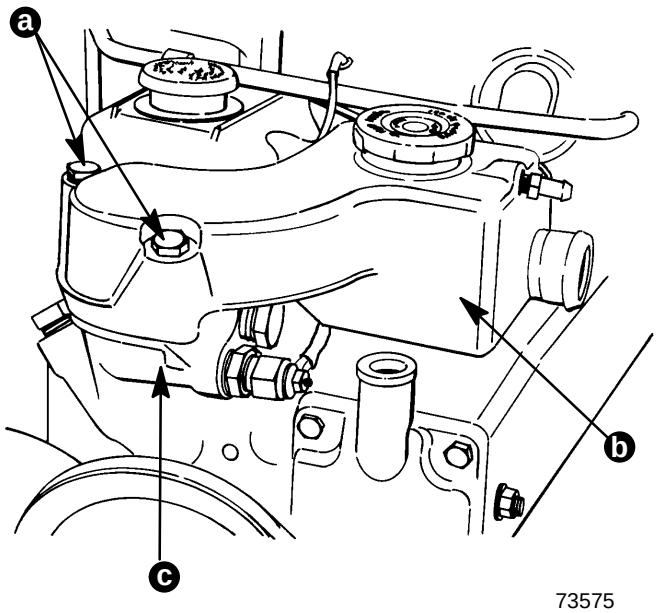
a - Inspect for Damage
b - Cam Lock Flange

6. Reinstall cap on reservoir or heat exchanger.

Thermostat

Removal

1. Drain coolant from cylinder block and exhaust manifold.
2. Disconnect hoses from thermostat cover attaching bolts and lock-washers, then remove cover and gasket.
3. Remove thermostat from thermostat housing.

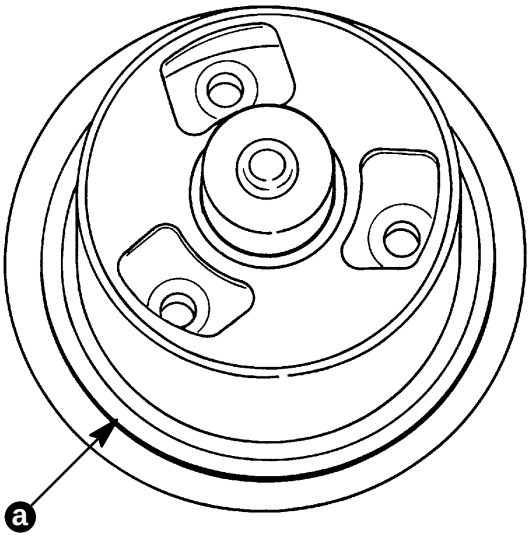


73575

a - Bolts
b - Reservoir
c - Thermostat Housing

Testing

1. Clean thermostat in soap and water to remove any deposits or debris.
2. Inspect thermostat for corrosion or other visible damage.
3. If thermostat is suspected of producing insufficient engine temperature, check thermostat for leakage by holding it up to lighted background. Light leakage around the thermostat valve indicates that thermostat is not closing completely and should be replaced. (A small amount of leakage at one or two points around the valve perimeter is acceptable.)



72717

a - Check for Light Leakage Around Perimeter of Valve

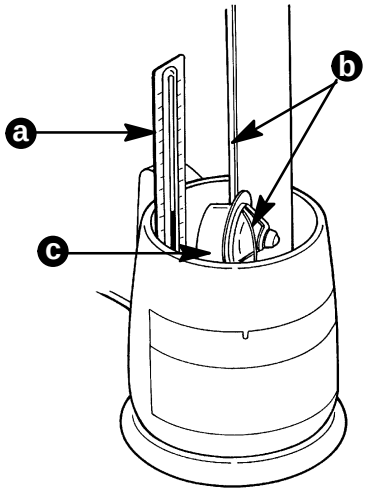
Brass Thermostat (Stainless Steel Similar)

Index

4. Check opening and closing temperature of thermostat (using a tester similar to the one shown), as follows:

   a. Fill tester to within 1 in. (25 mm) of top with tap water. Do not use distilled water.

   b. Open thermostat valve and insert thread. Position thermostat on nylon string so that it will be just below water level when suspended, then allow valve to close. Suspend thermostat in water.



72675

a - Thermometer
b - Nylon String
c - Thermostat

   c. Place thermometer in container and position so that bottom of thermometer is even with bottom of thermostat. Do not allow thermometer to touch container.

IMPORTANT: When performing instructions "d" and "e," water must be agitated thoroughly to obtain accurate results.

   d. Plug in tester and observe temperature at which thermostat opens (thermostat drops off thread). Thermostat must open at 138-145°F (59-63°C). Thermostat must be completely open at 170°F (77°C).

   e. Unplug tester and allow water to cool to a temperature 10°F (5°C) below specified temperature on thermostat. Thermostat must be completely closed at this temperature.

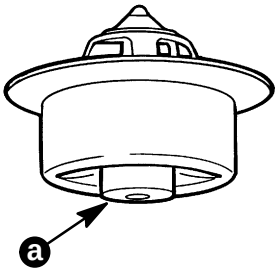
   f. Replace a thermostat that fails to meet all of the preceding tests.

Installation

1. Remove thermostat housing and gaskets. Discard gaskets.
2. Clean gasket surfaces on thermostat cover, thermostat housing and intake manifold.
3. Position lower gasket (with continuity rivets) on intake manifold. Place thermostat housing on gasket.

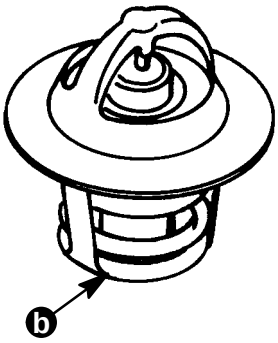
IMPORTANT: If gasket has continuity rivets, do not coat with Quicksilver Perfect Seal, or audio warning temperature switch may not work properly.

4. Install thermostat as shown, into thermostat housing.



Brass Thermostat

72674



Stainless Steel Thermostat

71801

⚠CAUTION

Avoid seawater pickup pump impeller damage. DO NOT operate engine without cooling water being supplied to seawater pickup pump.

5. With boat in the water and/or cooling water properly supplied to seawater pickup pump, start engine and inspect for leaks.

Changing Coolant

NOTICE

For information and procedures on draining the seawater cooling system, refer to SECTION 1B. For Cold Weather Or Extended Storage, refer to SECTION 1B.

Closed Cooling Section

Closed cooling section of closed cooling system should be kept filled year-round with recommended coolant solution. Do not drain closed cooling section for storage, as this will promote rusting of internal surfaces. If engine will be exposed to freezing temperatures, make sure that closed cooling section is filled with an ethylene glycol antifreeze and water solution, mixed to manufacturer's recommended proportions, to protect engine to lowest temperature to which it will be exposed. If necessary, change coolant.

Coolant Recommendations

⚠CAUTION

Alcohol or Methanol base antifreeze or plain water are not recommended for use in fresh water section of closed cooling system at any time.

It is recommended that the coolant section of closed cooling system be filled with 50/50 mixture of ethylene glycol antifreeze and water. In areas where the possibility of freezing DOES NOT exist, it is permissible to use solution of rust inhibitor and water (mixed to manufacturer's recommendations).

Change Intervals

Drain and flush coolant from the closed cooling system at least every two years or whenever exhaust gases have entered the system.

Draining Instructions

⚠WARNING

Allow engine to cool before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

IMPORTANT: A wire should be inserted into drain holes to ensure that foreign material is not obstructing the drain holes. On later models with two piece petcock, removal of petcock may be required so that wire can be inserted completely into drain hole.

IMPORTANT: Engine must be as level as possible to ensure complete draining of cooling system.

IMPORTANT: Closed cooling section must be kept filled year round with recommended coolant. If engine will be exposed to freezing temperatures, make sure closed cooling section is filled with an ethylene glycol antifreeze and water solution properly mixed to protect engine to lowest temperature to which it will be exposed.

IMPORTANT: Do not use Propylene Glycol Antifreeze in the closed cooling section of the engine.

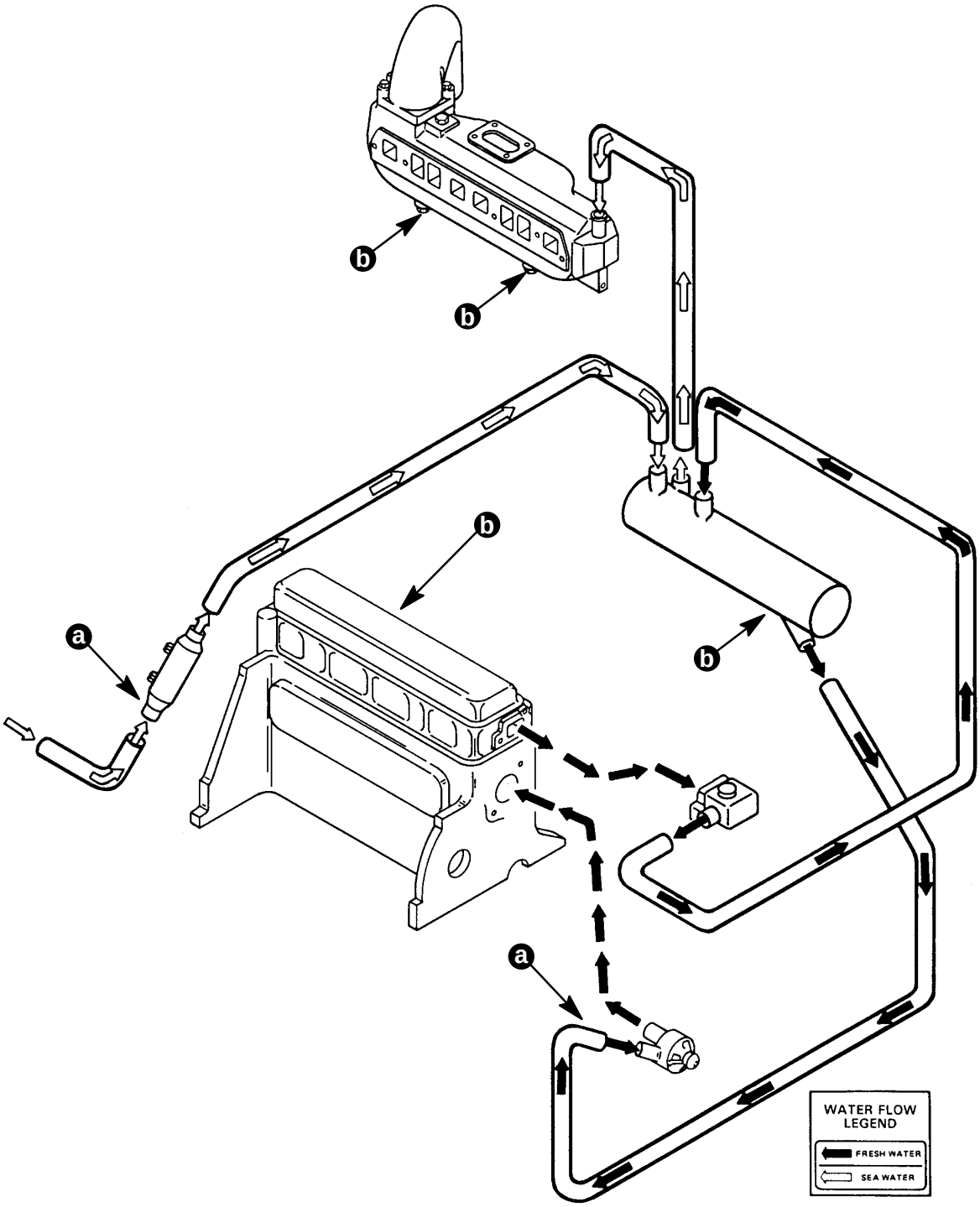
The following draining instructions apply to all engines equipped with closed cooling. The location of petcocks that require opening and hoses that require removal are represented on the following pages for the individual engines.

IMPORTANT: Observe precautions previously outlined before proceeding.

1. Remove pressure cap from coolant tank.
2. Drain coolant from locations as shown for your model and engine. (Refer to the appropriate diagram on the following "Draining Diagrams" page.)
3. After coolant has drained completely, coat threads of drain plugs with Quicksilver Perfect Seal and install drain plugs and hoses. Tighten clamps and drain plugs securely.
4. Remove coolant recovery bottle from mounting bracket and pour out coolant.
5. Clean system as outlined in "Cleaning System."
6. Fill system as outlined in "Filling Closed Cooling Section."

Index

Draining Diagram



73665

a - Remove and Lower Hoses To Drain
b - Remove Drain Plugs Repeatedly Clean Out Holes Using A Stiff Piece Of Wire, Until Entire System Is Drained.

Index

Cleaning System

Closed Cooling Section

Closed cooling section of the cooling system should be cleaned at least once every two years or whenever decreased cooling efficiency is experienced.

A good grade automotive cooling system cleaning solution may be used to remove rust, scale or other foreign material. Always follow manufacturer's instructions for the cleaner.

If closed cooling section is extremely dirty, a pressure flushing device may be used to flush out remaining deposits. Flushing should be done in direction opposite normal coolant flow to allow water to get behind deposits and force them out. Refer to instructions which accompany flushing device for proper hookup and flushing procedure.

NOTICE

For information and procedures for draining and flushing seawater section of cooling system, refer to SECTION 1B. For Cold Weather Or Extended Storage, refer to SECTION 1B.

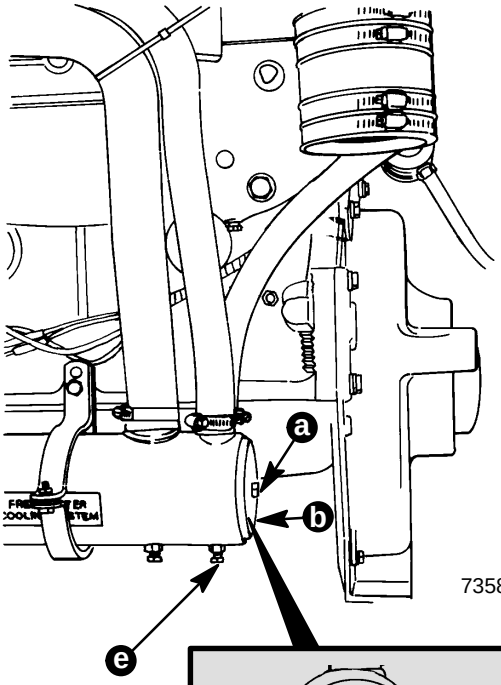
Seawater Section

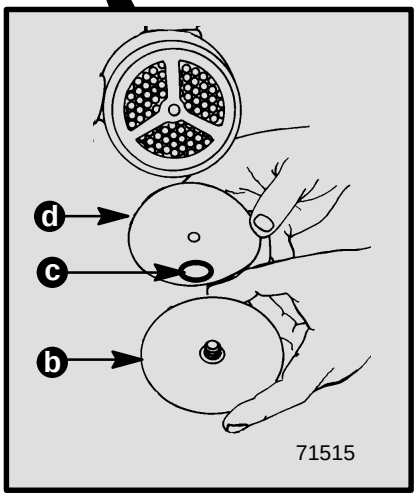
Cooling efficiency of an engine with closed cooling is greatly dependent upon heat transfer through the tubes within the heat exchanger. During engine operation, contaminants within the seawater (such as salt, silt, lime, etc.) collect on the inside of the tubes, thus reducing heat transfer and greatly decreasing heat exchanger efficiency. It is, therefore, recommended that the seawater section of the heat exchanger be cleaned at least once every two years or whenever decreased cooling efficiency is suspected, as follows:

IMPORTANT: It may be necessary to remove heat exchanger on some models. If heat exchanger is removed, be sure to refill closed cooling section with coolant.

1. Remove seawater drain plug from bottom of heat exchanger and allow water to drain. After water has drained completely, coat threads of drain plug with Quicksilver Perfect Seal and reinstall.

2. Remove bolts which secure end plate to each end of heat exchanger, then remove end plates, seal washers and gaskets. Discard seal washers and gaskets. Clean gasket material from end plate and heat exchanger.





a - Bolt
b - End Cap
c - Sealing Washer
d - Gasket
e - Drain Plug

3. Clean water passages in heat exchanger by inserting a suitable size wire brush into each passage. Use compressed air to blow loose particles out of water passages.

4. Apply Quicksilver Perfect Seal to both sides of new end plate gaskets, then reinstall end plates, using new gaskets and seal washers. (Be sure to install seal washers between end plates and gaskets.) Torque end plate bolts to specifications.

Index

⚠ CAUTION

Avoid seawater pickup pump impeller damage. DO NOT operate engine without water being supplied to seawater pickup pump.

5. With boat in the water and/or cooling water properly supplied to seawater pickup pump, start engine and inspect for leaks.

Flushing Seawater Section of Closed Cooling System

If engine is operated in salty, polluted or mineral-laden waters, seawater section of closed cooling system should be flushed periodically (preferably after each use) with fresh water to reduce corrosion and prevent the accumulation of deposits in the system. Seawater section also should be thoroughly flushed prior to storage.

⚠ WARNING

When flushing cooling system with boat out of the water, be certain that area in vicinity of propeller is clear and that no person is standing nearby. As a precautionary measure, it is recommended that propeller be removed.

⚠ CAUTION

Do not run engine above 1500 RPM when flushing. Suction created by seawater pickup pump may collapse flushing hose, causing engine to overheat.

⚠ CAUTION

If cooling system is to be flushed with boat in the water, seacock (if so equipped) must be closed, or water inlet hose must be disconnected and plugged to prevent water from flowing into boat.

⚠ CAUTION

To prevent engine or stern drive unit damage DO NOT run engine or drive unit without water being supplied to water intake openings on gear housing.

⚠ CAUTION

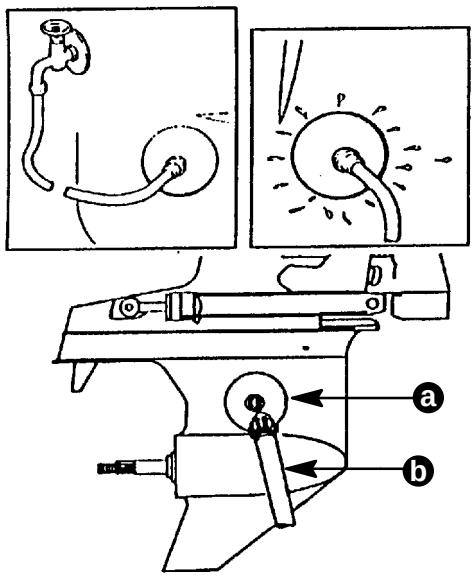
Watch temperature gauge at dash to ensure the engine does not overheat.

1. Connect flushing attachment as follows:

NOTE: *If flushing cooling system with boat in water, raise drive unit to trailer position, install flushing attachment and lower drive unit to full IN/DOWN position.*

   a. Install Quicksilver Flushing Attachment (or equivalent) over water intake openings in gear housing.

   b. Connect hose between flushing attachment and water tap.



72672

a - Quicksilver Flushing Attachment
b - Garden Hose

⚠ CAUTION

If cooling system is to be flushed with boat in the water, seacock (if so equipped) must be closed, or water inlet hose must be disconnected and plugged to prevent water from flowing into boat.

   c. Close seacock (if so equipped) or disconnect and plug seawater inlet hose.

2. Partially open water tap (approximately 1/2 maximum capacity) and allow drive unit and cooling system to fill completely. Do not use full tap water pressure.

NOTE: *Drive unit is full when water is discharged out of drive unit, and/or seawater section of closed cooled system is full when water is discharged through propeller.*

3. Place remote control lever in NEUTRAL position and start the engine. Operate engine at idle speed in NEUTRAL gear for 10 minutes or until discharge water is clear, then stop engine.

Index

4. Shut off tap water. Remove hose and flushing attachment from drive unit. On belt driven seawater pickup pump models, also remove hose and flushing attachment from pump inlet.
5. Follow instructions “a” or “b.”

⚠CAUTION

If boat is in the water, seacock (if so equipped) must remain closed until engine is to be restarted, to prevent contaminated water from flowing back into cooling system. If boat is not fitted with a seacock, water inlet hose must remain disconnected and plugged, to prevent water from flowing into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel with the warning that the seacock must be opened or the water inlet hose reconnected prior to starting the engine.

a. **If equipped with seacock:** Observing precaution above, open seacock.
b. **If NOT equipped with seacock:** Observing precaution above, remove plug from seawater inlet hose and reconnect seawater inlet hose. Tighten hose clamps securely.

Draining Seawater Section of Closed Cooling System

NOTICE

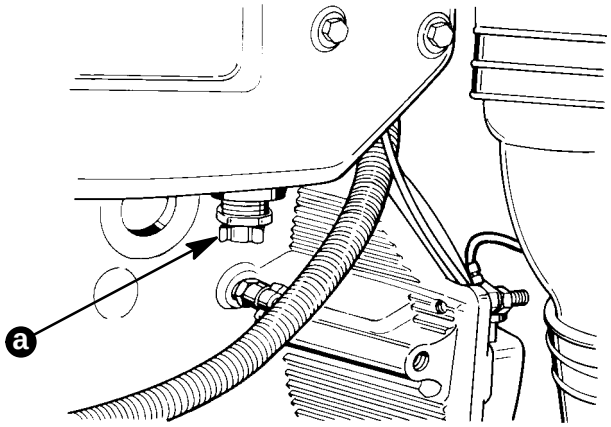
For cold weather or extended storage information and procedures, refer to SECTION 1B.

NOTE: *It may be necessary to lift, bend, or lower hoses to allow water to drain completely when hoses are disconnected.*

⚠CAUTION

If boat is in the water or is to remain in the water, seacock (if so equipped) must remain closed until engine is to be restarted, to prevent contaminated water from flowing back into cooling system. If boat is not fitted with a seacock, water inlet hose must be left disconnected and plugged, to prevent contaminated water from flowing into cooling system and/or boat. As a precautionary measure, attach a tag to the ignition switch or steering wheel with the warning that the seacock must be opened or the water inlet hose reconnected prior to starting the engine.

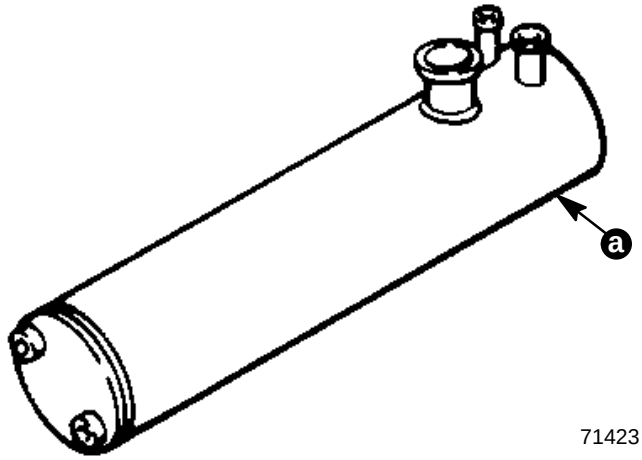
1. Close seacock (if so equipped) or disconnect and plug seawater inlet hose.
2. Check that engine is as level as possible to ensure complete draining of cooling system.
3. Remove drain plugs from exhaust manifold.



71424

a - Drain Plug (Port and Starboard)

4. Remove aft (rear) drain plug from heat exchanger.

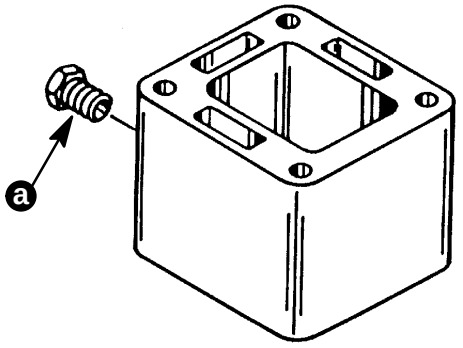


71423

a - Drain Plug

Index

5. If equipped with 3 in. (76 mm) or 6 in. (152 mm) risers, remove drain plug as shown from riser.



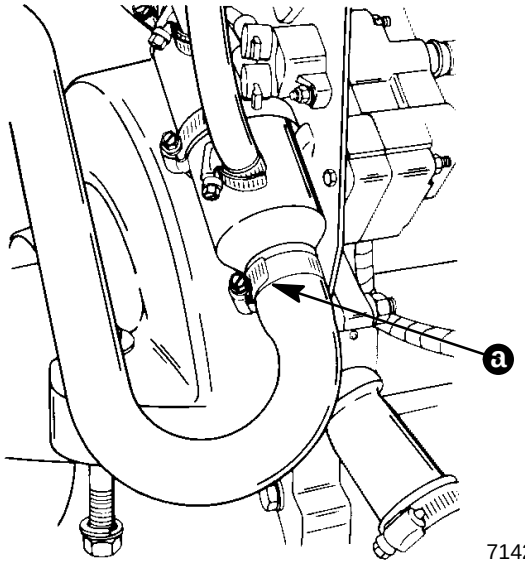
73175

a - Drain Plug (Removed)

6. Repeatedly clean out drain holes using a stiff piece of wire. Do this until entire system is drained.

NOTE: *It may be necessary to lift, bend, or lower hoses to allow water to drain completely when hoses are disconnected.*

7. Remove the power steering fluid cooler seawater hose, as shown.

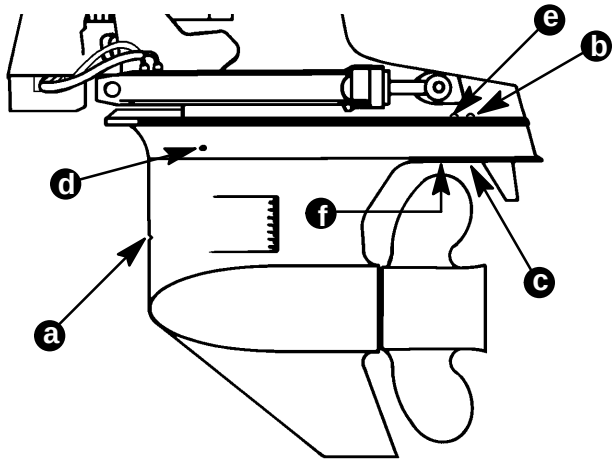


71422

a - Hose, Seawater Pump-to-Cooler

8. After seawater section of cooling system has been drained completely, coat threads of drain plugs with Quicksilver Perfect Seal and reinstall. Tighten drain plugs securely. Reconnect hoses and tighten all hose clamps securely. **If NOT equipped with seacock:** seawater inlet hose must remain disconnected and plugged until engine is to be restarted.

9. Insert a small wire (repeatedly) to make sure that vent holes and water drain holes and passages (as shown) are unobstructed and open.



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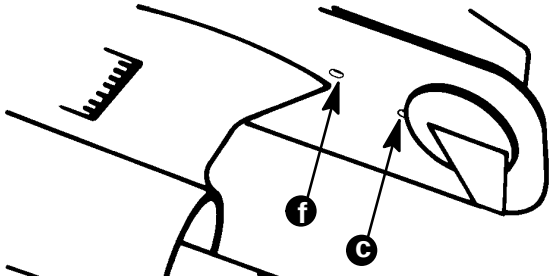


70134

a - Speedometer Pitot Tube
b - Trim Tab Cavity Vent Hole
c - Trim Tab Cavity Drain Passage
d - Gear Housing Water Drain Hole
(One Each - Port and Starboard)
e - Gear Housing Cavity Vent Hole
f - Gear Housing Cavity Drain Hole

10. Crank engine over SLIGHTLY with starter motor to purge any water trapped in seawater pickup pump. DO NOT ALLOW ENGINE TO START.

Recommissioning

NOTICE

Refer to "Cold Weather or Extended Storage," "Precautions," in this section, BEFORE proceeding.

1. Check that all cooling system hoses are connected and tight and all petcocks and drain plugs are installed and tight.
2. Inspect all drive belts.

Index

3. Perform all lubrication and maintenance specified for completion “At Least Once Yearly” in maintenance chart, except items which were performed at time of engine layup.
4. For drive unit, refer to appropriate stern drive manual.
5. Install fully charged battery. Clean battery cable clamps and terminals to help retard corrosion.
6. Start engine and closely observe instrumentation to ensure that all systems are functioning properly.
7. Carefully inspect entire engine for fuel, oil, water and exhaust leaks.
8. Check fuel pump sight tube.
9. Check steering system and shift and throttle controls for proper operation.

Filling Closed Cooling Section

NOTICE

See “Specifications” for approximate closed cooling system capacity and coolant recommendation.

⚠WARNING

Do not remove coolant cap when engine is hot. Coolant may discharge violently.

⚠CAUTION

Alcohol or Methanol based antifreeze or plain water are not recommended for use in fresh water section of cooling system at any time.

⚠CAUTION

Front of engine should be higher than rear to purge trapped air out of the system during initial filling. This will minimize the possibility of air being trapped in the closed cooling section which can cause engine to overheat.

1. Remove coolant cap on heat exchanger.
2. Fill closed cooling system with coolant mixture through heat exchanger fill neck until coolant level is 1 in. (25 mm) below filler neck.

⚠CAUTION

Avoid seawater pickup pump impeller damage and subsequent overheating damage to stern drive unit. DO NOT operate engine without water being supplied to seawater pickup pump.

⚠CAUTION

Models with belt drive seawater pickup pump must be in the water when running engine because garden hose will not supply enough water to system at higher RPM.

3. With pressure cap off, start engine and run at fast idle (1500-1800 RPM). Add coolant solution to heat exchanger, as required, to maintain coolant level 1 in. (25 mm) below filler neck.
4. After engine has reached normal operating temperature (thermostat is fully open), and coolant level remains constant, fill heat exchanger to bottom of filler neck.
5. Observe engine temperature gauge to make sure that engine operating temperature is normal. If gauge indicates excessive temperature, stop engine immediately and examine for cause.
6. Install pressure cap on heat exchanger.
7. Remove cap from coolant recovery reservoir and fill to FULL mark with coolant solution. Reinstall cap.
8. With engine still running, check hose connection, fittings and gaskets for leaks.

IMPORTANT: Engine overheating is often due to air being trapped in closed cooling section. Purge air by running engine at 2000 RPM for 10 minutes.

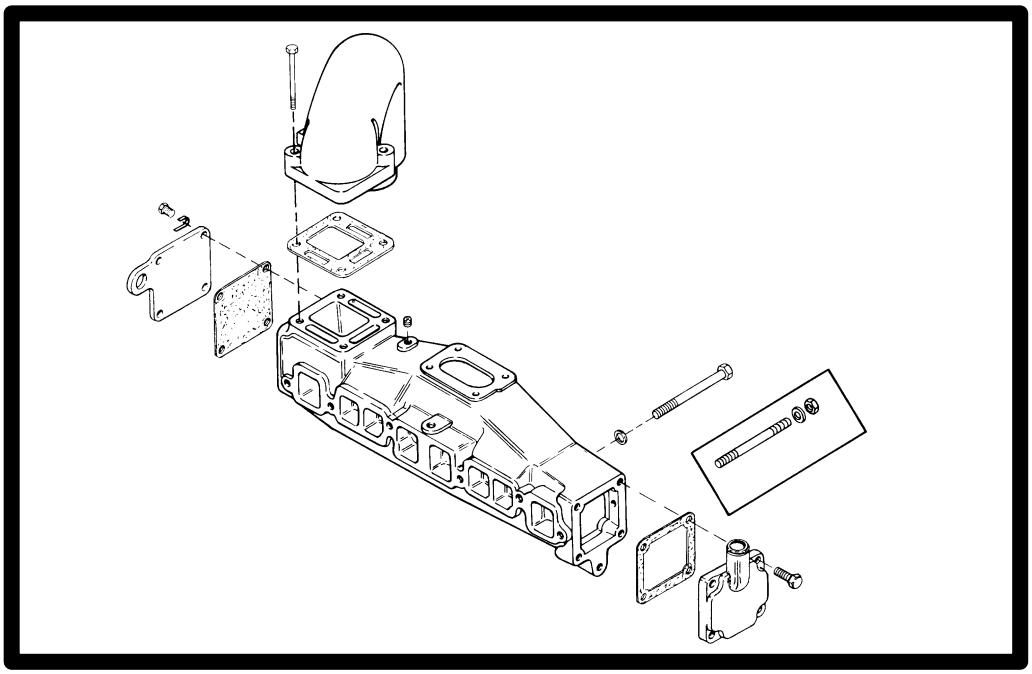
⚠WARNING

Allow engine to cool before removing pressure cap. Sudden loss of pressure could cause hot coolant to boil and discharge violently. After engine has cooled, turn cap 1/4 turn to allow any pressure to escape slowly, then push down and turn cap all the way off.

9. Recheck coolant level after first open-throttle boat test and add coolant, if necessary.
10. Maintain coolant level in coolant recovery reservoir between ADD and FUL[illegible]ks with engine at normal operating temper[illegible]

Index

EXHAUST SYSTEM



MANIFOLD

6

C

Index

Table of Contents

	Page
Torque Specifications	6C -1
Sealants	6C -1
Exhaust System Requirements	6C -1
Engines With Thru Drive Unit Exhaust	6C -1
Removal	6C -1
Cleaning And Inspection	6C -2
Installation	6C -2
Upper Exhaust Pipe And Shutter Replacement	6C -3
Lower Exhaust Pipe Replacement	6C -4

NOTICE

For information and procedures on troubleshooting, refer to SECTION 1C.

Torque Specifications

Fastener Location	Lb. Ft.	N·m
Hose Clamps	Securely	
Exhaust Elbow	20-25	27-34
Exhaust Pipe to Gimbal Housing	20-25	27-34

Sealants

Description	Part Number
Quicksilver Loctite 8831	92-32609-1
Quicksilver Perfect Seal	92-34227--1
Quicksilver Bellows Adhesive	92-86166

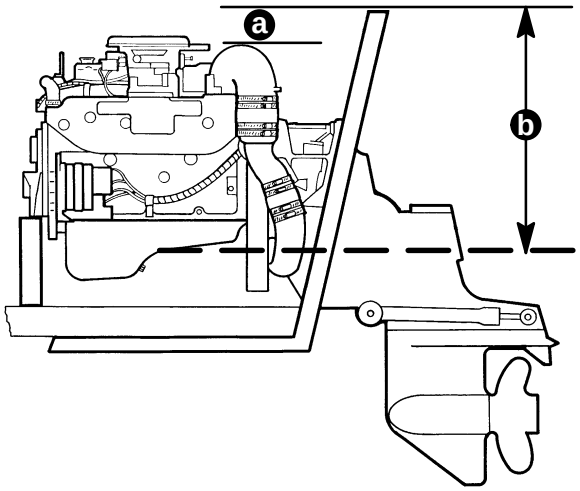
Exhaust System Requirements

Engines with Thru Drive Unit Exhaust

⚠ CAUTION

It is the responsibility of the boat manufacturer or installing dealer to properly locate the engine and install the exhaust system. Improper installation may allow water to enter the exhaust manifolds and combustion chambers and severely damage the engine. Damage caused by water in the engine will not be covered by MerCruiser Warranty, unless this damage is the result of defective part(s).

Determine if exhaust elbow risers are required by taking measurements “A” and “B” as shown, with boat at rest in the water and maximum load aboard. Subtract “B” from “A”. If “A” minus “B” is less than specified in chart, select appropriate size exhaust elbow riser kit and exhaust extension kit that will correctly position exhaust elbow.



50734

a - From Waterline to Top of Transom
b - From Highest Point on Exhaust Elbow to Top of Transom

Model	“A” Minus “B” Must Be At Least:
MCM 3.0L/3.0LX	**11 in. (279mm)**

Removal

1. Disconnect battery cables from battery.
2. Drain water from cylinder block, exhaust manifold and exhaust elbow.
3. Disconnect throttle cable at carburetor.
4. Disconnect exhaust hose and cooling hoses.
5. Disconnect fuel line at carburetor.

⚠WARNING

Gasoline is extremely flammable and highly explosive under certain conditions. Be sure electrical source to engine is disconnected. Do not smoke or allow sources of spark or open flame in area when installing new pump. Wipe up any spilled fuel immediately.

6. Disconnect crankcase ventilation hose at rocker arm cover.
7. Disconnect wires connected to electric choke.
8. Remove exhaust manifold fasteners; remove manifold assembly and discard gaskets.
9. Remove exhaust elbow.

Cleaning and Inspection

1. Clean gasket material from all surfaces and wash parts in solvent.
2. Inspect all parts carefully. Machined surfaces must be clean and free of all marks and deep scratches, or water and exhaust leaks may result.
3. Check water passages for foreign material. Passages must be clean for efficient cooling.
4. If more thorough inspection is desired, pipe plugs may be removed from exhaust manifold and exhaust elbow.

IMPORTANT: If plugs are removed, coat threads with Perfect Seal before reinstalling.

IMPORTANT: If manifold to cylinder head studs have broken, install all new studs with Loctite 8831 AFTER checking head and manifold surfaces for warpage. Also use all new manifold attaching nuts.

5. Check for cracks.
6. To test manifold body for leaks, block off plates, plugs or short hoses with plugged ends must be used. One block off plate must have a threaded hole for attaching compressed air hose. Use new gaskets when installing block off plate(s). Apply 40 PSI (276 kPa) of air pressure and submerge manifold in water. Air bubbles will indicate a leak.

Installation

If exhaust manifold body requires replacement, transfer all parts (from old manifold) to new manifold body.

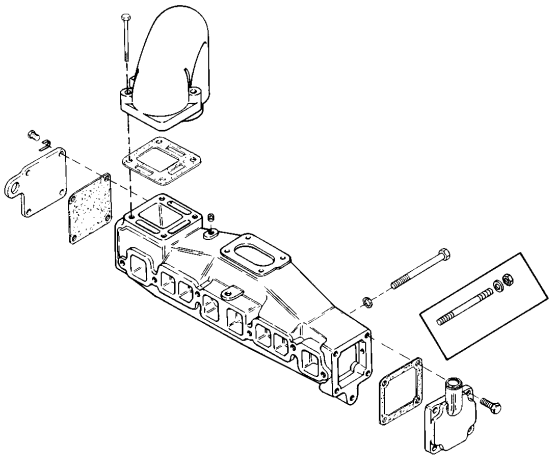
1. Position new gasket on head and install manifold in position, making sure gasket is in place.
2. Tighten fasteners evenly and torque to 23 lb. ft. (33 N·m), starting in center and working out toward ends.

IMPORTANT: After engine has been brought up to operating temperature, allow engine to cool. Retorque manifold fasteners.

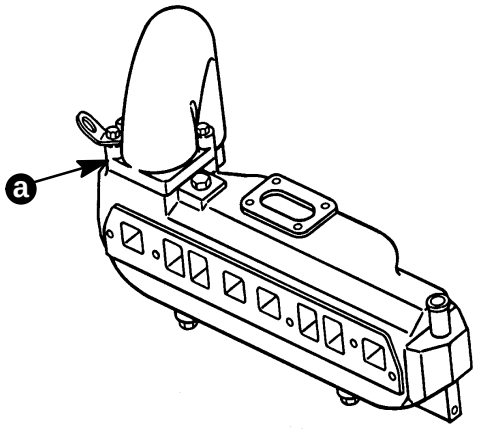
3. Install carburetor (if removed) and connect crankcase ventilation hose at rocker arm cover.

4. Install exhaust elbow using new gasket. Torque to 25 lb. ft. (34 N·m).

IMPORTANT: Install gasket as shown.



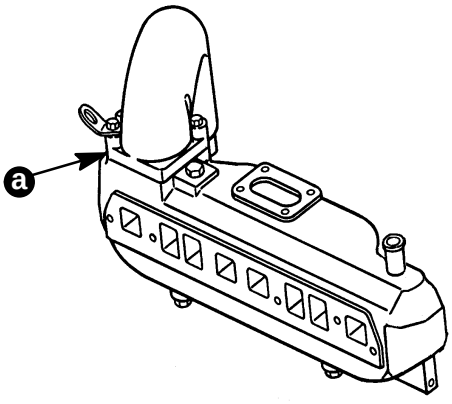
Manifold <u>With</u> End Caps



50677

a - Install the gasket in the same position as manifolds with bolted on end caps.

Manifold <u>Without</u> End Caps (Earlier Version)



50677

a - Install the gasket in the same position as manifolds with bolted on end caps.

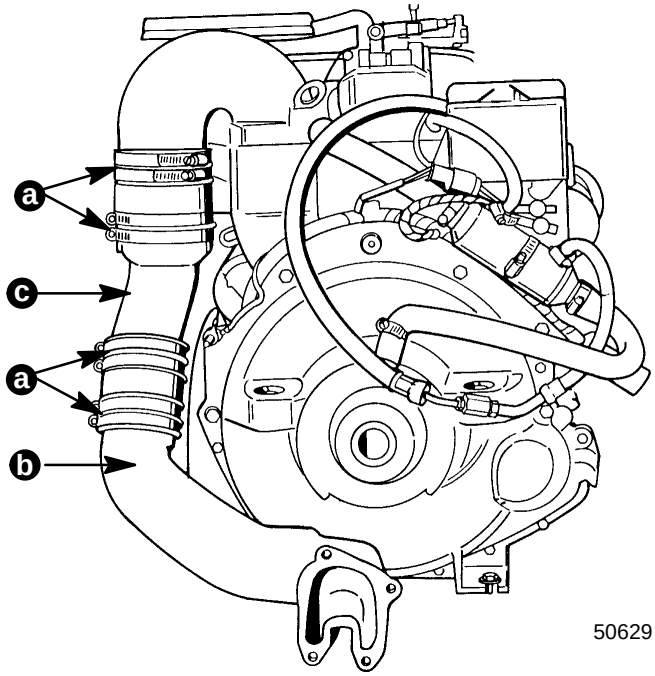
Manifold <u>Without</u> End Caps (Later Version)

5. Connect throttle cable to carburetor. Adjust as outlined in “Removal, Installation and Alignment.”
6. Connect fuel line and electric choke wires.
7. Reinstall exhaust and cooling hoses.
8. Reconnect battery cables to battery. Tighten securely.
9. Start engine, check for exhaust, water and fuel leaks and adjust carburetor idle speed and mixture.

Upper Exhaust Pipe and Shutter Replacement

IMPORTANT: Engine does not have to be removed, however, exhaust elbow may have to be removed.

1. Loosen exhaust bellows clamps.
2. Remove hose clamps.
3. Remove intermediate exhaust pipe.
4. Remove exhaust tube.



50629

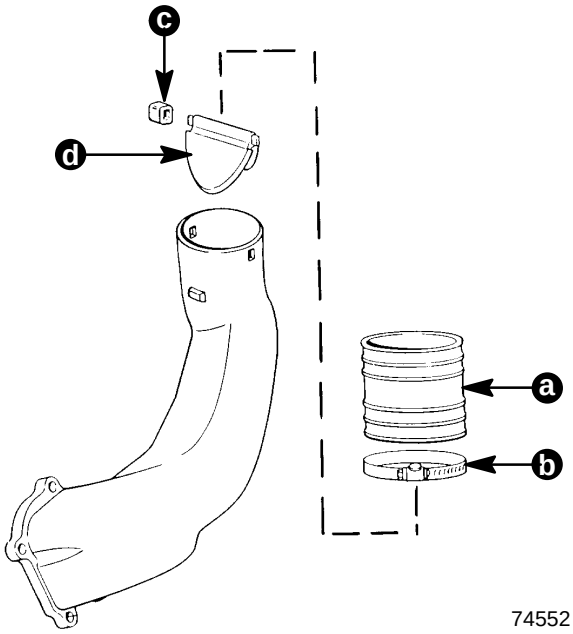
a - Clamps
b - Lower Exhaust Tube
c - Intermediate Exhaust Pipe

Index

⚠ WARNING

Be sure to read and follow package label direction when using Bellows Adhesive.

5. Replace shutter (in lower pipe), as shown.
   a. Coat both mating surfaces of hose and lower pipe with Bellows Adhesive. Allow to dry and then slide hose on lower pipe. Tighten clamps securely.
   b. Place clamps over bellows and connector hose, then install upper exhaust pipe.
   c. Making sure all clamps are contacting exhaust elbow, upper pipe and lower pipe, tighten clamps securely.

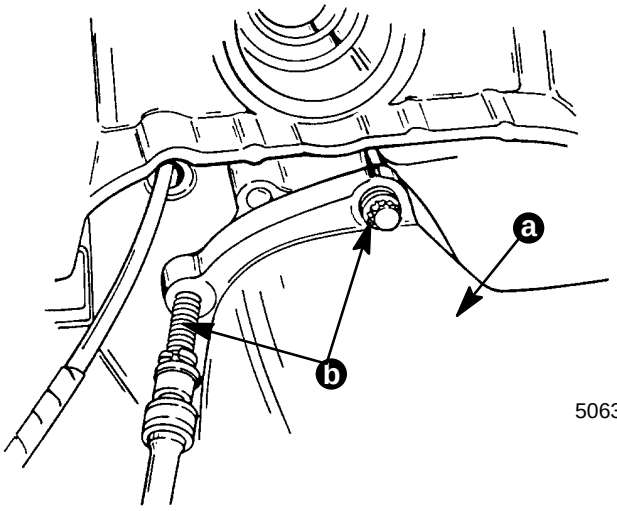


74552

a - Connector Hose - Remove to Change Shutter
b - Clamps (2)
c - Grommet (2)
d - Shutter - Opens Downward

Lower Exhaust Pipe Replacement

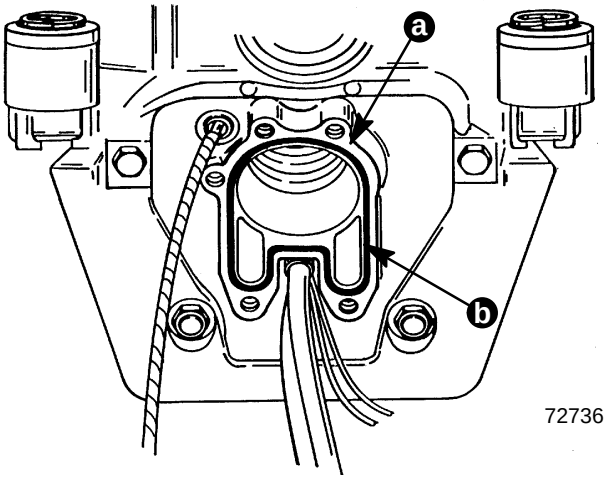
1. Remove stern drive unit.
2. Remove engine, then upper exhaust pipe.
3. Remove screws and lockwashers that secure lower exhaust pipe to gimbal housing.



50634

a - Exhaust Pipe
b - Screws (4) - 2 Under Exhaust Pipe

4. Remove exhaust pipe and O-ring.
5. Clean mating surfaces on pipe and gimbal housing.
6. Place O-ring in groove of gimbal housing.



72736

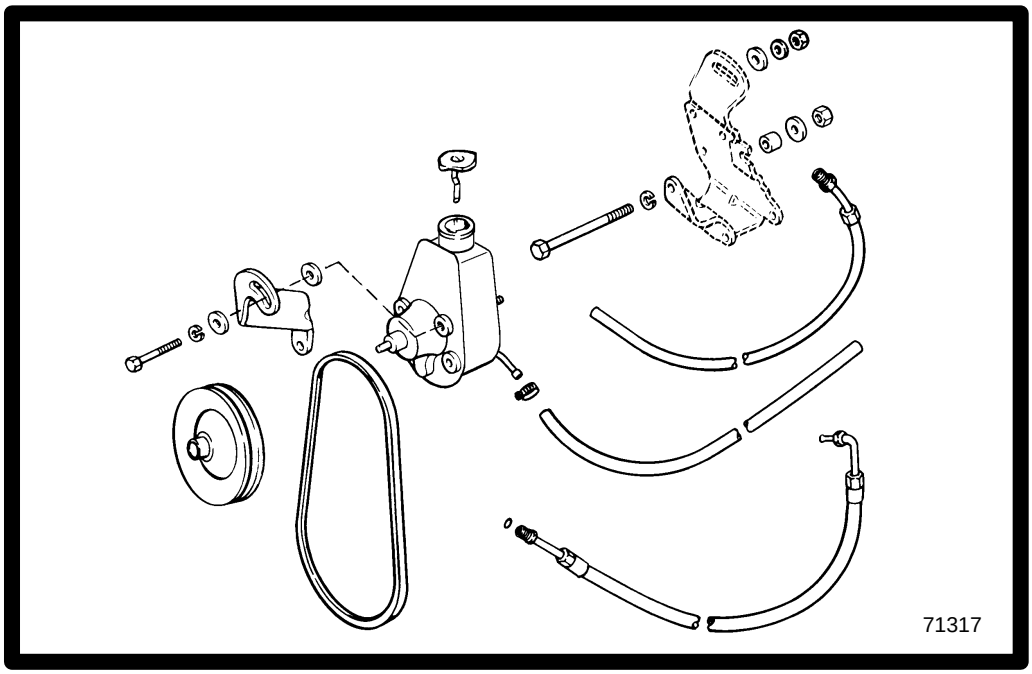
a - Mating Surfaces
b - O-ring

7. Reinstall lower exhaust pipe with screws and lock-washers, torque to specifications. Be certain that o-ring remains seated in groove, properly sealing joint to prevent leakage.
8. Reinstall upper exhaust pipe, then engine.
9. Reinstall stern drive unit.

POWER STEERING

7

A



PUMP

Index

Table of Contents

	Page
Torque Specifications	7A-1
Tools/Sealants/Fluids	7A-1
Precautions	7A-1
Checking Power Steering Pump Fluid Level	7A-1
With Cold Engine	7A-1
With Engine Warm From Operation	7A-2
Filling and Air Bleeding Power Steering System	7A-2
Pump Drive Belt Tension Adjustment	7A-2
Pump Pulley Replacement	7A-3
Removal	7A-3
installation	7A-3
Power Steering Pump And Cooler	7A-4
Replacment	7A-4
Installation	7A-7
Low Pressure Hose (Control Valve-to-Cooler)	7A-8
Removal	7A-8
Installation	7A-8
Priority Valve Kit (79691A1) Information	7A-10
Installing Reservoir	7A-10
Installing Priority Valve	7A-11
Filling System with Fluid	7A-15
Maintenance	7A-15
System Flow Diagram	7A-16

Index

Torque Specifications

Fastener Location	Lb. Ft.	Lb. In.	N•m
Crankshaft Pulley to Harmonic Balancer	20		27
Harmonic Balancer to Crankshaft	60		81
Pump Mounting Bracket to Engine	30		41
Recirculation Pump Pulley		240	27

Tools/Sealants/Fluids

Description	Part Number
Pulley Installer	91-93656A1
Quicksilver Perfect Seal	92-34227-2
Dexron II (ATF)	Obtain Locally
Kent-Moore Special Tools	
Pulley Removal Tool	J-25034
Can be ordered from: Kent-Moore Tools, Inc. 29784 Little Mack Roseville, MI 48066 Phone: (313) 574-2332	
Can be ordered from: Kent-Moore Tools, Inc. 29784 Little Mack Roseville, MI 48066 Phone: (313) 574-2332	

Precautions

⚠CAUTION

Do not operate engine without cooling water being supplied to water pickup pump or water pump impeller will be damaged and subsequent overheating damage to engine may result.

⚠WARNING

Always disconnect battery cables from battery before working on engine to prevent fire or explosion.

⚠CAUTION

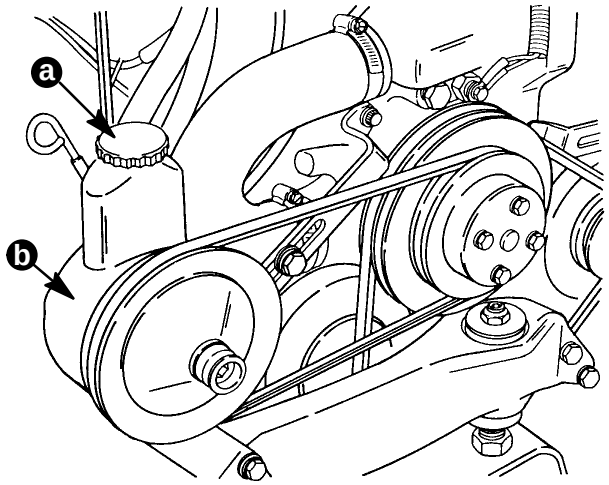
Do not pry on power steering pump or alternator when adjusting belt tension. Serious damage may result.

Checking Power Steering Pump Fluid Level

IMPORTANT: Use only Quicksilver Power Trim and Steering Fluid, or automatic transmission fluid (ATF), Dexron II, in power steering system.

WITH COLD ENGINE

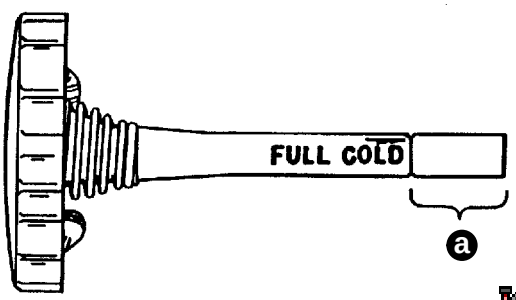
1. Stop engine and position drive unit so that it is straight back.
2. Remove fill cap/dipstick from poewr steering pump and note fluid level.



74558

a - Fill Cap
b-Power Steering Pump

3. Level should be between ”FULL COLD” mark and bottom of dipstick.



72519

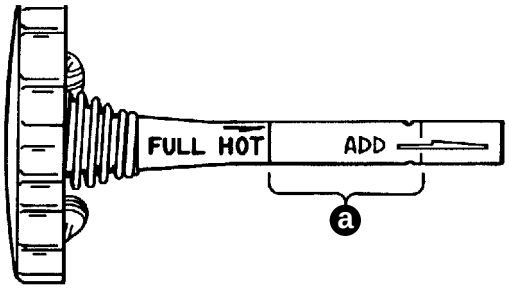
a - Proper Fluid Level With Engine Cold

Index

4. If fluid level is low but still visble in pump reservoir, add fluid thru fill cap opening to bring level up to ”FULL COLD” mark on dipstick. Do not overfill.

WITH ENGINE WARM FROM OPERATION

1. Stop engnie and position drive unit so that it is straight back.
2. Remove fill cap/dipstick from power steering pump and note fluid level.
3. Level should be between the ”FULL HOT” mark and ”ADD” mark on the dipstick.



72518

a - Proper Fluid Level With Engine Warm

4. If level is low (below ”ADD” mark), but still visible in pump reservoir, add fluid thru fill cap opening to bring level up to ”FULL HOT” mark on dipstick. Do not overfill.

Filling and Air Bleeding Power Steering System

IMPORTANT: Powert steering system must be filled exactly as explained, following, to be sure that all air is bled from the system. All sir msut be removed, or fluid in pump may foam during operation and be discharged from pump reservoir. Faomy fluid may also cause poewr steering system to become spongy resulting in poor boat control.

1. Position drive unit so that it is straight back. Remove cap from power steering pump and check fluid level with dipstick attached to fill cap (provided) Add fluid as required, to bring level up to correect level.

IMPORTANT: Use only Quicksilver Power Trim and Steering Fluid, or automatic transmission fluid (ATF), Dexron II, in power steering system.

2. Turn steering whell back-and-forth to end of travel i each direction several times: then, recheck fluid level and add fluid, if necessary.
3. Install vented fill cap.

⚠CAUTION

DO NOT operate engine without water being supplied to seawater pump pickup or pump impeller may be damaged and subsequent overheating damage to engine may result.

4. Start engine and run at fast ilde (1000-1500 RPM) until engine reaches normal operating temperature. During this time, turn steering wheel back-and-forth to end of travel in each direction several times.
5. Position drive unit so that it is straight back and stop engine. Remove fill cap from pump. Allow any foam in pump reservoir to disperse; then, check fluid level and fluid as required, to bring level up to ”FULL HOT” mark on dipstick. Do not overfill. Install fill cap securely.

IMPORTANT: Drive unit must be positioned straight back and power steering fluid must be hot to accurately check fluid level.

6. If fluid is still foamy (in Step 5), repeat Steps 4 and 5 until fluid does not foam and level remains constant.

Pump Drive Belt Tension Adjustment

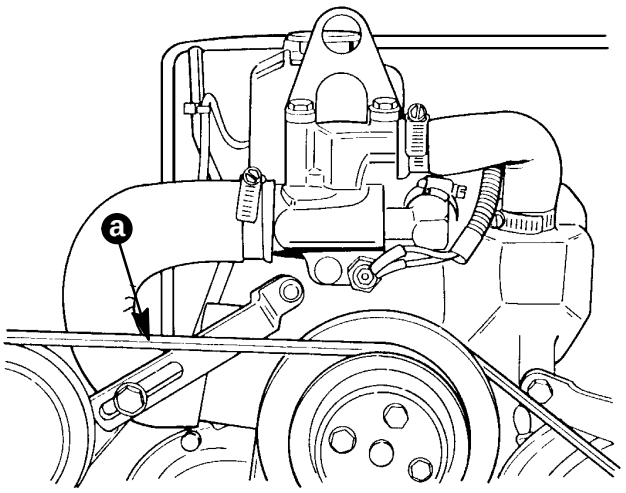
IMPORTANT: Refer to Precautions in this section before proceeding.

IMPORTANT: DO NOT pry in pump body.

1. Install drive belt on pulleys and adjust tension as follows:
   a. Pivot pump attain tension.

Index

b. Tighten retaining bolts.



74557

a - Belt Deflection No More Than 1/4 Inch (6 mm) Maximum

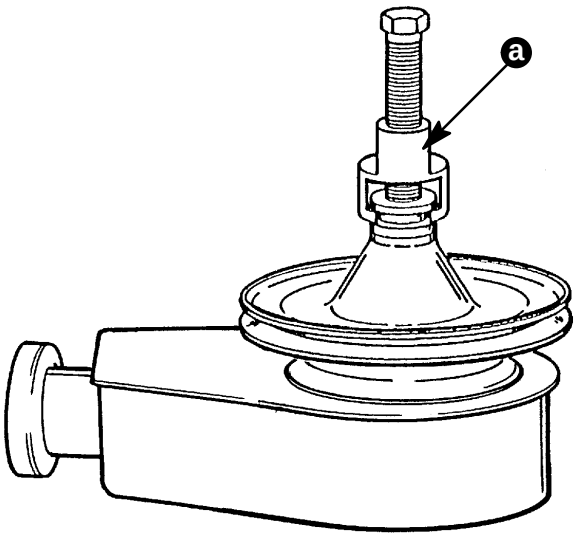
2. Check belt tension using either of two methods, following and readjust pump, if necessary, to obtain proper belt tension.
   a. Using a strand tension guage, take gauge reading at midpoint of power steering pump belt. Gauge should read 75-95 lbs. (334-423 N·m).
   b. Check belt tension by pushing down on upper strand of belt at belt midpoint. Belt should depress 1/4 in. (6 mm).

Pump Pulley Replacement

REMOVAL

IMPORTANT: Kent-Moore Tool J-25034 must be used to remove the pressed-on pulleys used on power steering pumps. This tool has an end on it that will not mushroom the end of the pump shaft. DO NOT use Kent-Moore Tool J-21239 to remove these pulleys. This tool has a tapered end and will damage the shaft.

3. Install Kent-Moore Tool J-25034 on end of pulley and shaft as shown.
4. While holding tool with suitable wrench, turn threaded screw until pulley is removed.



72821

a - Kent-Moore Pulley Removal Tool (J-25034)

INSTALLATION

Install pulley, as follows, using pulley installer tool (91-93656A1), and a long straight edge:

5. Place pulley on pump shaft.
6. Thread stud all the way into pump shaft. Place bearing over stud. Do not use spacer from kit.
7. Thread nut onto shaft. Thread tool shaft (and nut) all the way onto stud (threaded into pump pulley).
8. Using a long straight edge (to check drive belt alignment), turn large pusher nut until drive belt is parallel to straight edge.

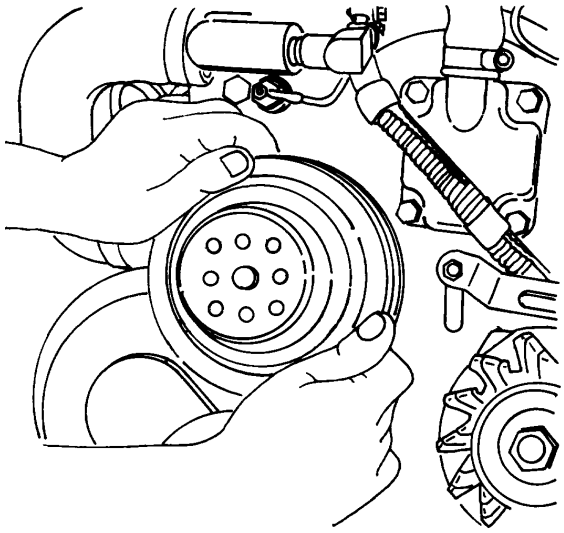
Index

Power Steering Pump And Cooler

Replacment

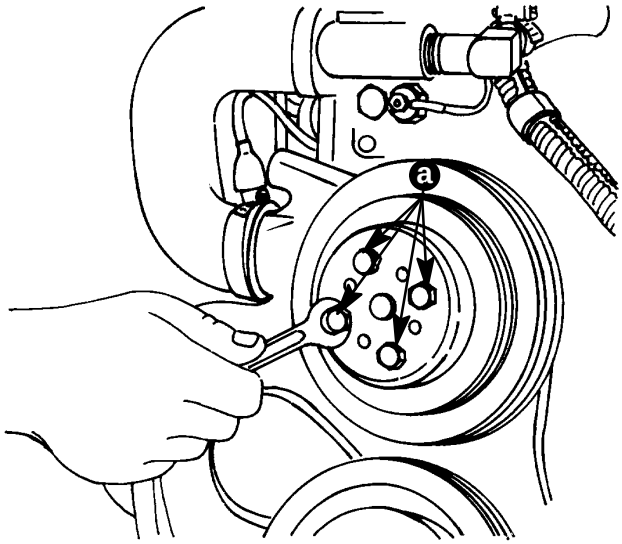
IMPORTANT: Refer to ”Precautions”, in this section BEFORE proceding.

1. Install pulley.



74562

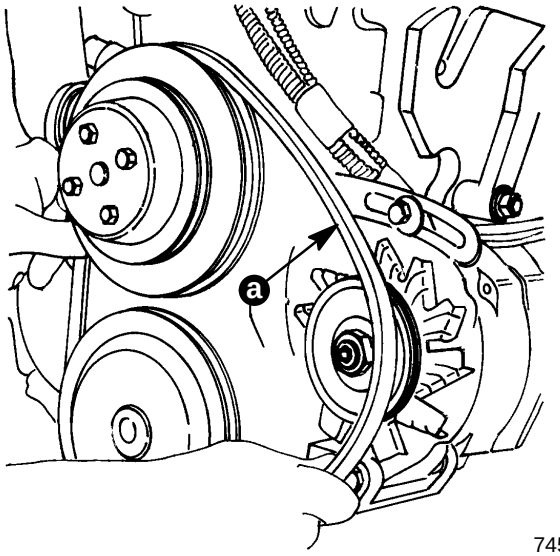
2. Install boltsand torque to 20 lb. ft. (27 N·m).



74563

a – Bolts and Lockwashers

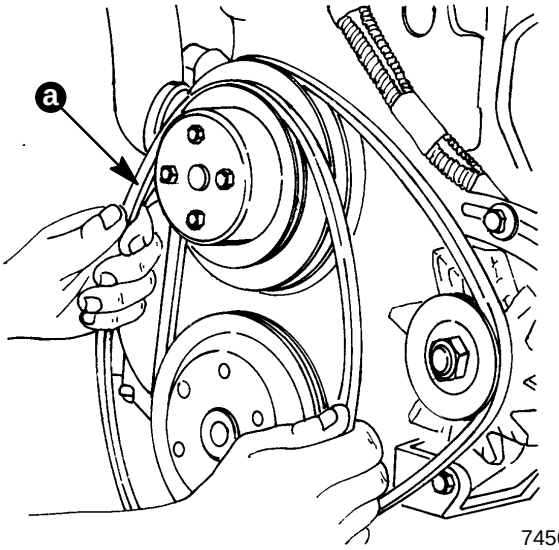
3. Install 40 inch (1016 mm) drive belt.



74564

a - 40 inch (1016 mm) Drive Belt

4. Install 37 inch (940 mm) drive belt over circulating pump pulley.

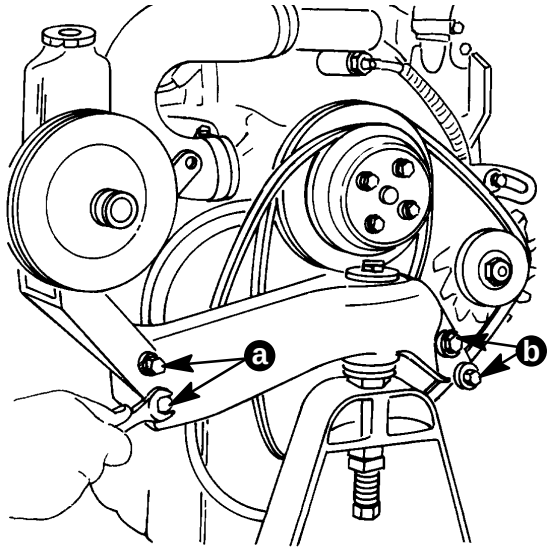


74565

a - 37 inch (940 mm) Drive Belt

Index

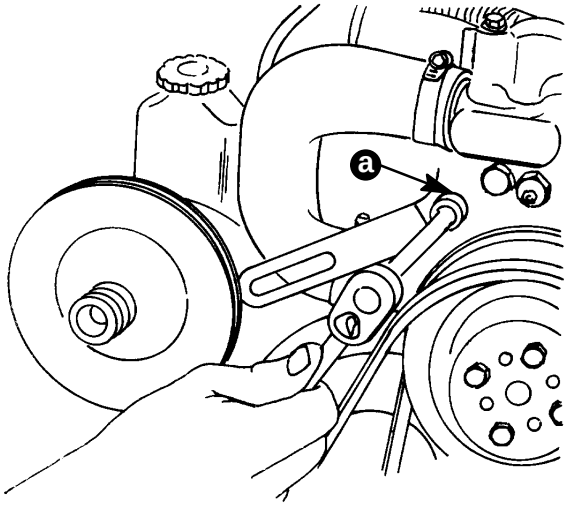
5. Install front mount assembly with power steering pump assembly. Tighten bolts securely.



74558

a - 2-3/4 inch (70 mm) Bolts, Washers and Lockwashers. Tighten securely.
b - Bolts, Washers and Lockwashers. Tighten securely.

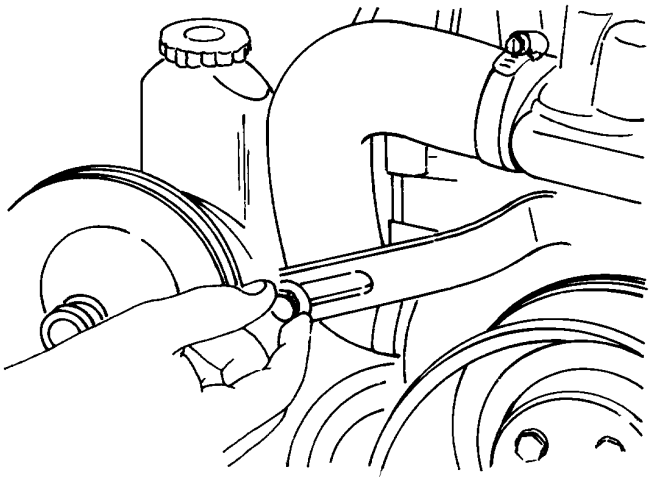
6. Attach power steering pump bracket to engine. Torque bolt to 30 lb. ft. (41 N·m).



74559

a - 1-1/4 inch (32 mm) Long Bolt Without Closed Cooling. 1-1/2 inch (38 mm) Long Bolt With Closed Cooling.

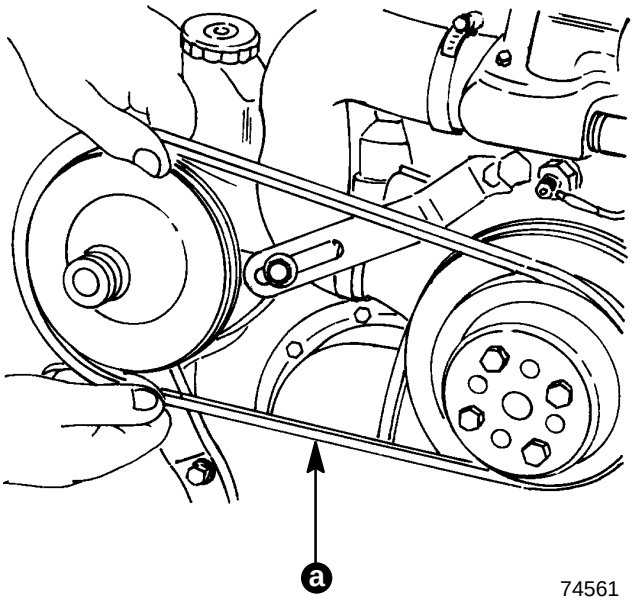
7. Attach power steering pump brace to pump.



74560

a - 7/8 inch (22 mm) Long Bolt and Washer

8. Install 37 inch (940 mm) drive belt over pump pulley.



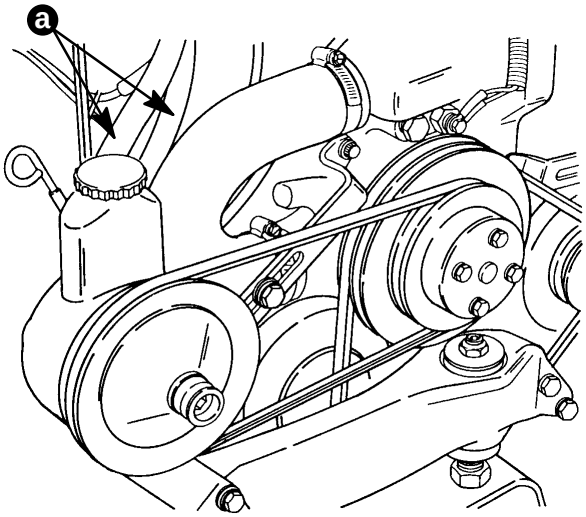
74561

a - 37 inch (940 mm) Drive Belt

9. Adjust drive belt tension.

Index

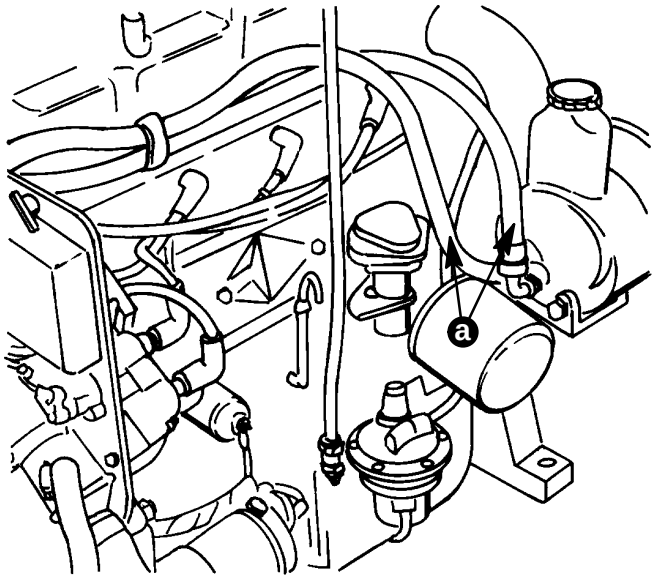
10. Route hydraulic hoses as shown.



50629

DDIS Ignition

a - Hydraulic Hose Routing

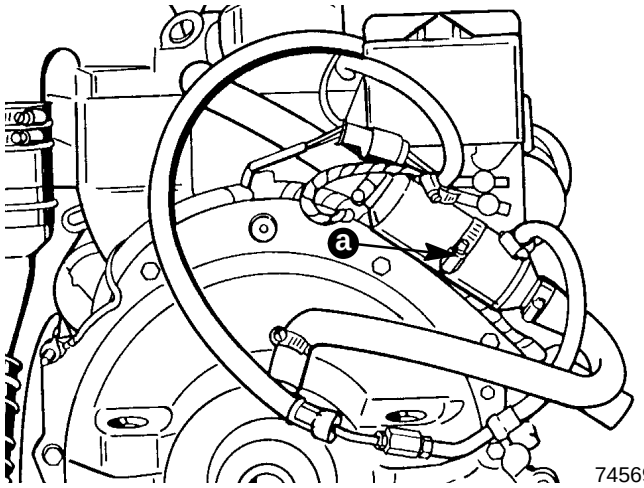


74566

Breaker Points Ignition

a - Hydraulic Hose Routing

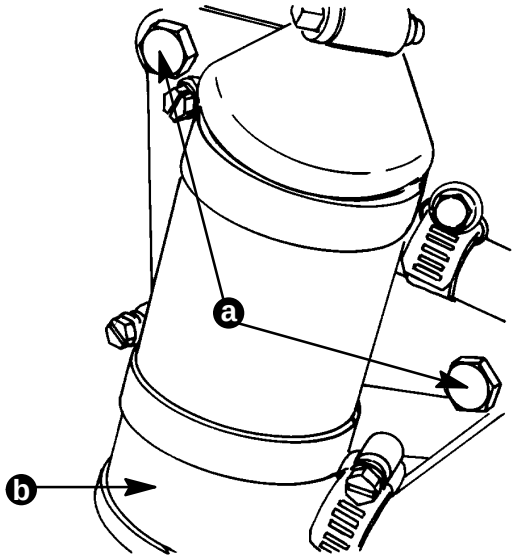
11. **DDIS AND EST MODELS:** Install fluid cooler and tighten hose clamp-screw securely.



74569

a – Clamp-Screw, Tighten Securely

12. **BREAKER POINTS IGNITION MODELS:** Install fluid cooler and tighten screw securely.

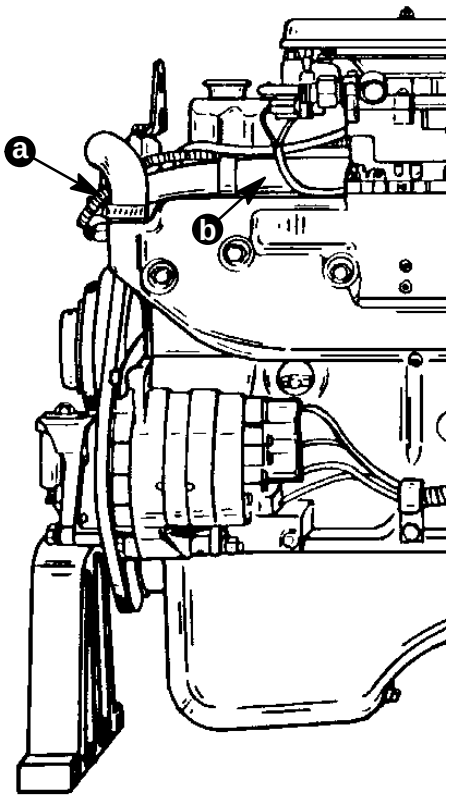


74585

a - 1 inch (25 mm) Bolts
b - Power Steering Fluid Cooler

Index

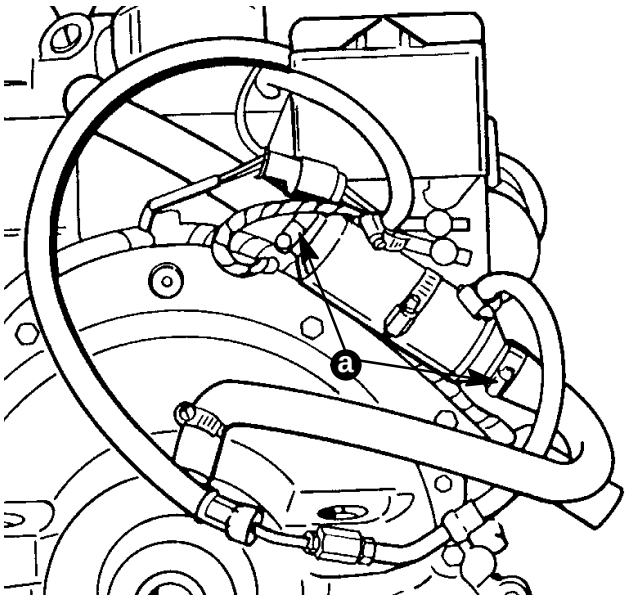
13. Install long water hose and tighten hose clamps securely.



74568

a - Hose Clamps

14. Install water hoses to power steering fluid cooler and tighten clamps securely.

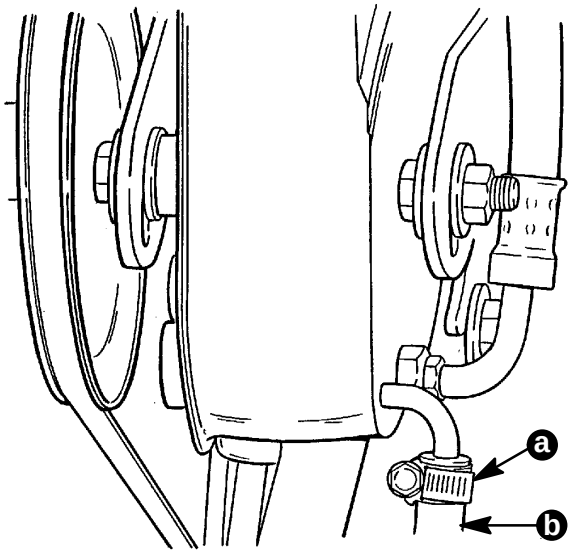


74569

a - Hose Clamps

INSTALLATION

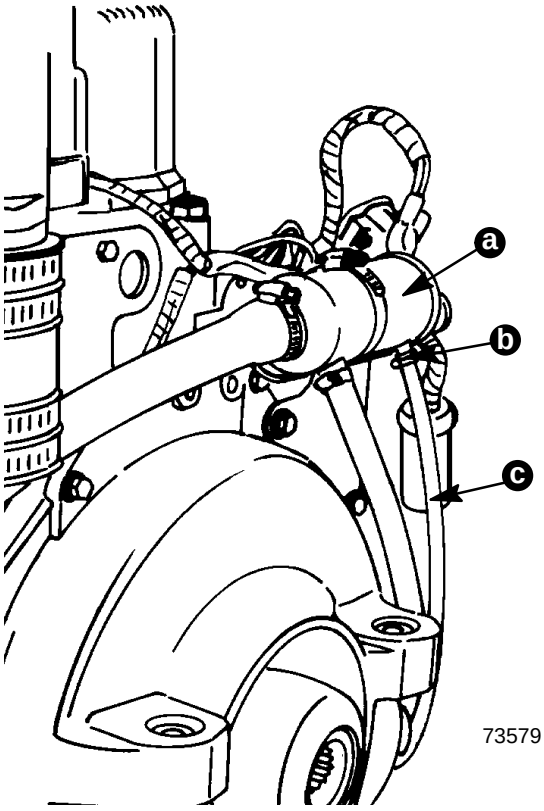
1. Using hose clamp, install new hose on back of pump. Tighten clamp securely.



72848

a - Hose Clamp
b - Hose

2. Using hose clamp, install hose on fluid cooler. Tighten clamp securely.



73579

a - Fluid Cooler
b - Hose Clamp
c - Hose

Index

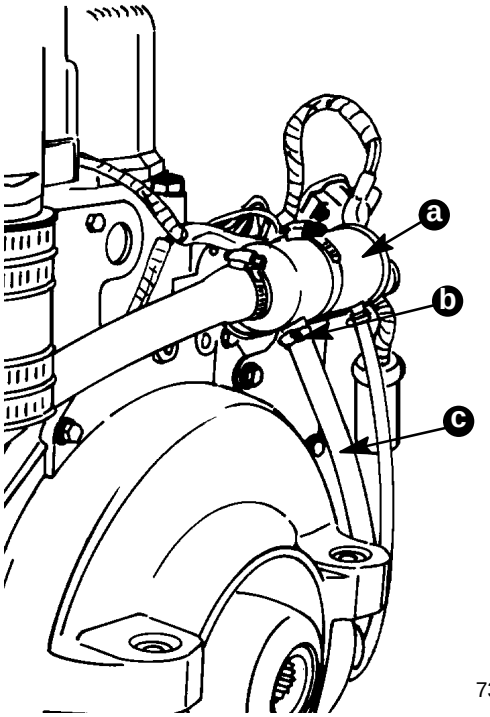
3. Fill and air bleed system. Refer to Section 1B - “Maintenance” (see “Table of Contents”).

Low Pressure Hose (Control Valve-to-Cooler)

REMOVAL

NOTE: *Catch fluid that drains from hose, cooler and pump in a suitable container.*

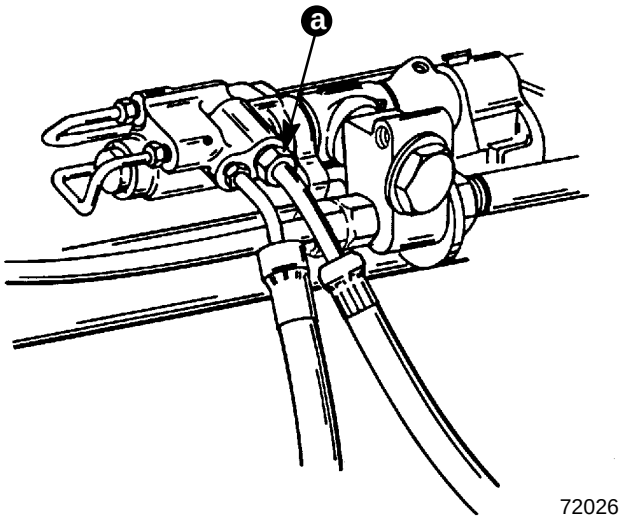
1. Loosen hose clamp and remove hose from fluid cooler.



73579

a - Fluid Cooler
b - Hose Clamp
c - Hose

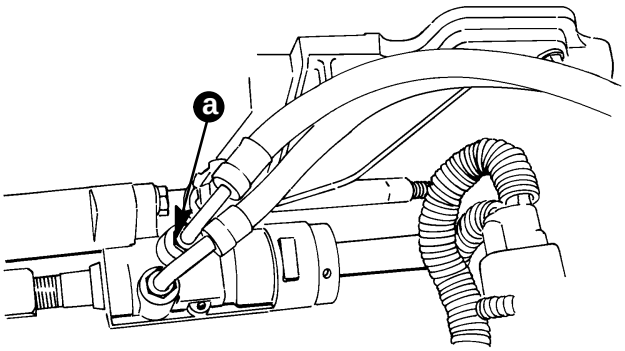
2. Remove large fitting from control valve at transom. Remove hose.



72026

Earlier Style Control Valve

a - Large Fitting



73786

Later Style Control Valve

INSTALLATION

⚠CAUTION

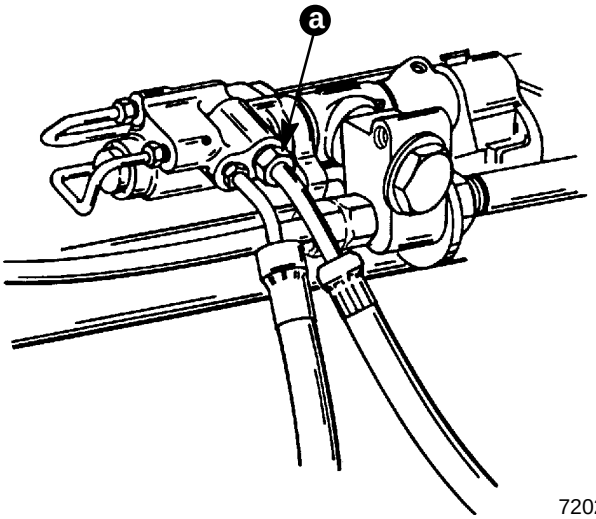
Route hoses exactly as shown below. This will help avoid stress on the hose fittings and will help avoid kinks in the hoses.

IMPORTANT: Be careful to not cross-thread or over-tighten hose fittings.

Index

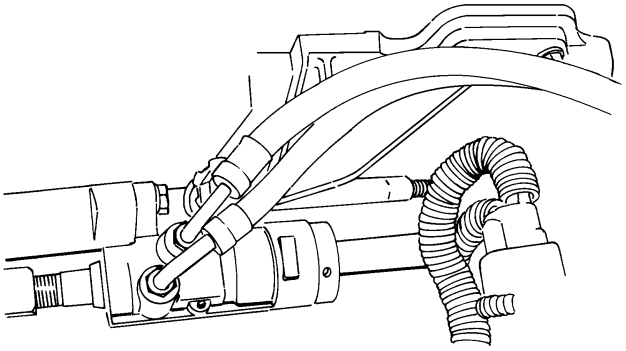
3. Thread large fitting into control valve. Position hose properly (as prior to removal).

Earlier Style Control Valve: Torque large fitting to 20-25 lb. ft. (27-34 N·m).



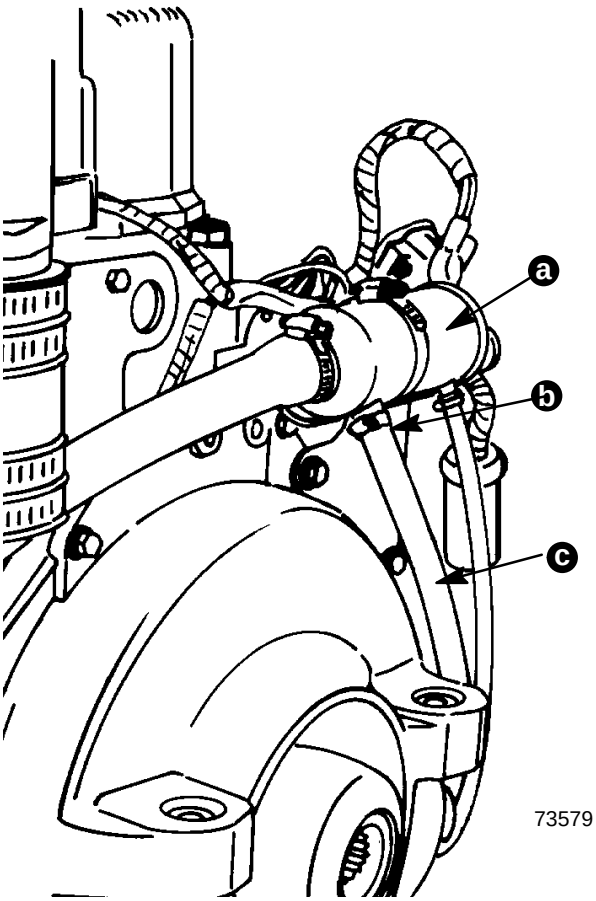
a - Large Fitting

Later Style Control Valve: Torque fittings to 23 lb. ft. (31 N·m)



4. Route hose along flywheel housing and secure with J-clamp(s) provided.

5. Using hose clamp, install hose on fluid cooler. Tighten clamp securely.



a - Fluid Cooler
b - Hose Clamp
c - Hose

6. Fill and air bleed system. Refer to Section 1B - “Maintenance” (see “Table of Contents”).

Index

Priority Valve Kit (79691A1) Information

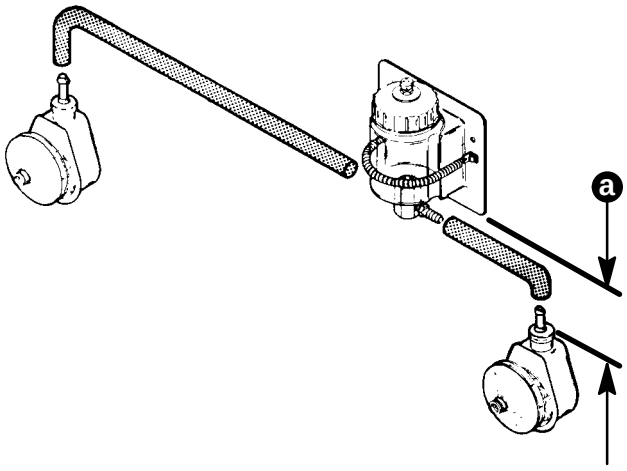
This kit information (in “Installation Instruction” form) is provided to assist personnel when servicing dual installations where both engines are equipped with power steering pumps, coolers, related hardware and hoses, and one transom assembly is equipped with power steering.

Although the system may already be installed, refer to appropriate sections and follow instructions that relate to your task when servicing those components.

NOTE: *A system flow diagram is located on the last page of this section.*

Installing Reservoir

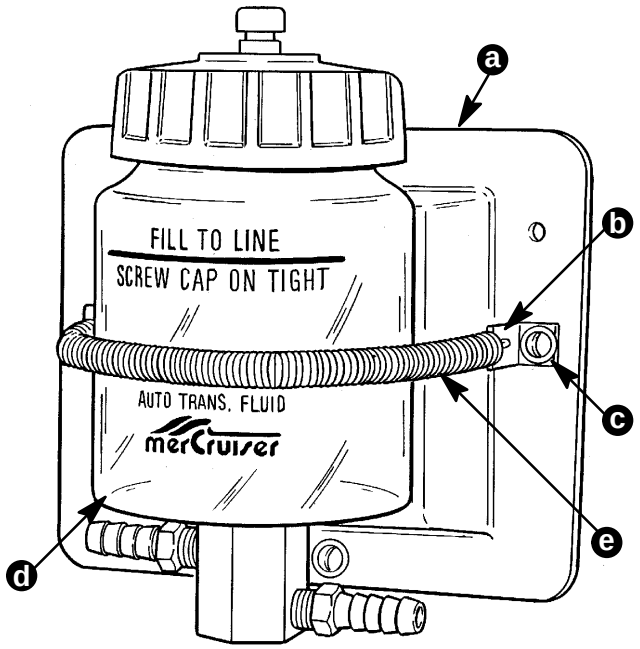
1. Mount reservoir bracket.
   a. Find a location between both power steering pumps that affords both accessibility and easy visual inspection of fluid level. Location must be at least 6 in. (152 mm) higher than pump cap to allow fluid from reservoir to flow freely to pumps (preferably on transom or on forward engine compartment wall).
   b. Install reservoir mounting bracket with hardware supplied.



71402

a - Measurement - 6 In. (152 mm) Minimum

2. Position bottle reservoir in mounting bracket and secure with retainer spring.

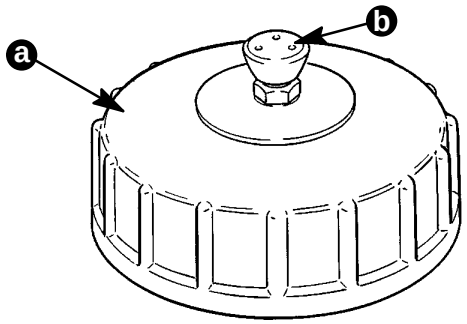


72854

a - Reservoir Bracket
b - Reservoir Spring Retainer Tab
c - Screw and Washer (Not Shown in This View)
d - Reservoir Bottle
e - Retainer Spring

IMPORTANT: A two-way valve is required on the reservoir cap for cold weather operation below 40°F (4°C).

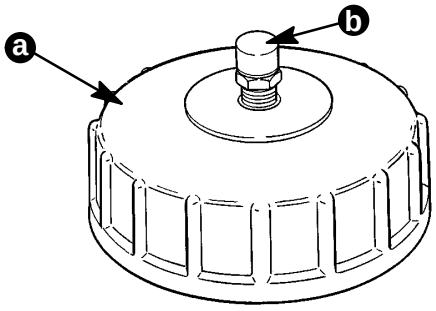
3. If required, install two-way valve in reservoir cap by removing vent from cover and replacing it with a two-way check valve.



72855

a - Reservoir Cap
b - Vent

Index



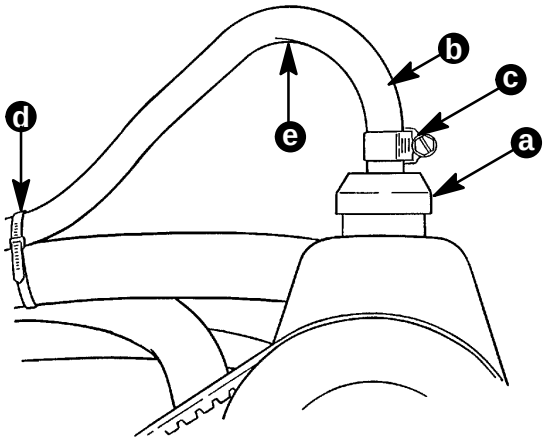
72856

a - Reservoir Cap
b - Two-Way Valve (Installed)

4. Cut two hoses (from bulk hose supplied) of sufficient length to extend from bottom fittings on reservoir to fill caps on power steering pumps. Allow extra hose for routing.

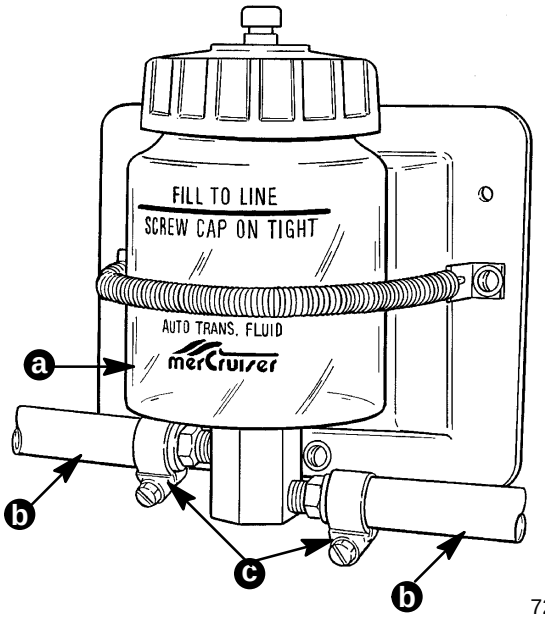
IMPORTANT: When routing and installing hoses in the following steps, be sure that the bend radius in the hose is sufficient to eliminate a load being placed on power steering pump fill cap.

5. Connect hoses, that were just cut, to reservoir and power steering pump caps (from kit). Secure with hose clamps. Tighten securely.
6. Secure hoses with Sta-Straps to keep them below reservoir fluid level line and away from heat and moving parts.



72857

a - Power Steering Pump Cap (Port and Starboard)
b - Hose to Reservoir
c - Hose Clamp
d - Sta-Straps
e - Bend Radius (Port and Starboard)

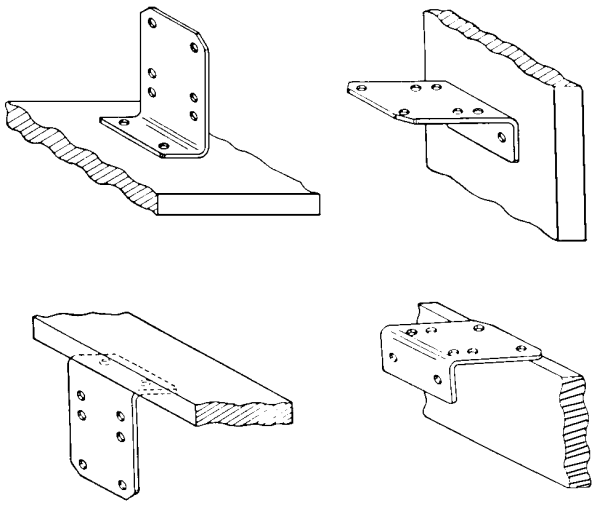


72858

a - Reservoir
b - Hoses from Pumps
c - Hose Clamps

Installing Priority Valve

NOTE: *Priority valve mounting bracket can be used in various mounting configurations.*

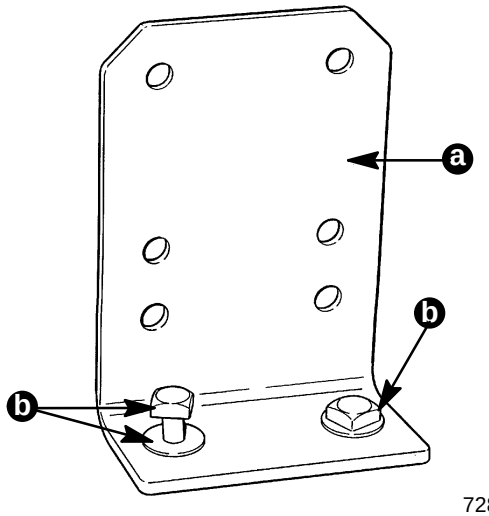


71403

1. Install priority valve mounting bracket.
   a. Find a central location that will be accessible for making and checking hose connections. Ensure that location will allow 2 in. (51 mm) or more, above and below priority valve for hose connections and routing (preferably on a stringer near transom).

Index

b. Mount bracket using lag bolts and washers supplied.

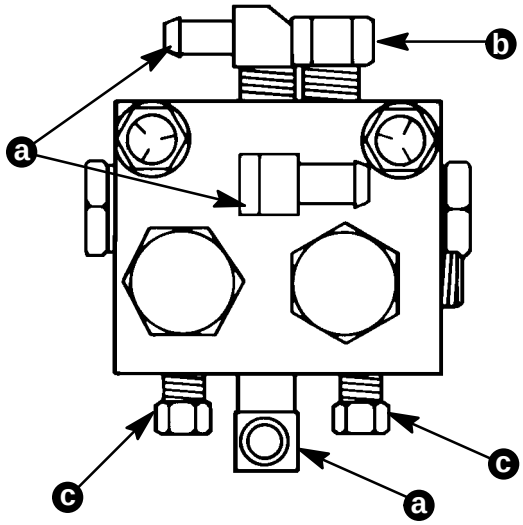


72859

a - Mounting Bracket
b - Lag Bolts and Washers

NOTE: *The 90° elbow locations on priority valve are marked with a "T" stamped into the valve.*

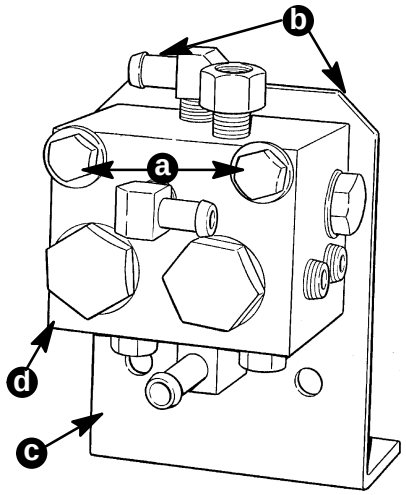
2. Apply liquid pipe joint sealer to threads and install fittings into priority valve.



71404

a - 90° Elbow
b - Large Inverted Flare Fitting
c - Small Inverted Flare Fitting

3. Mount priority valve on bracket. Torque bolt to 120 lb. in. (14 N·m).



72860

a - Bolt and Washer
b - Washer and Nut (Not Shown in This View)
c - Bracket
d - Priority Valve

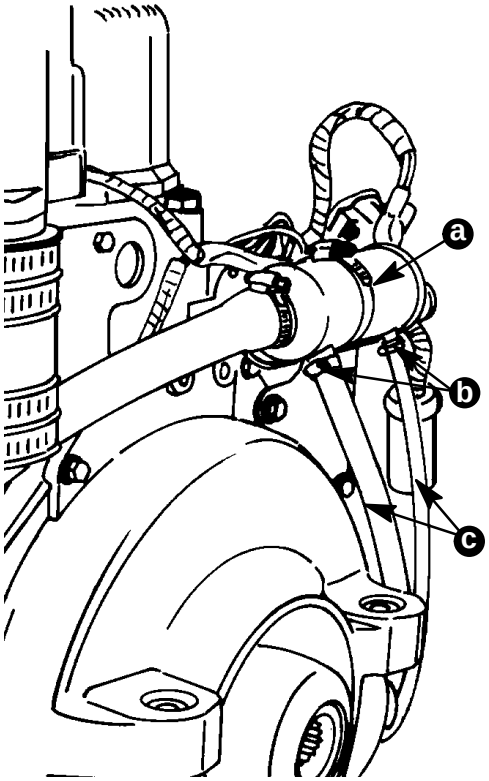
NOTE: *Engines with power steering are equipped with a hose that is connected to the power steering fluid cooler. A fitting on the other end of the hose would normally be connected to the power steering control valve. These hoses are not used and are replaced with bulk hose supplied with priority valve kit.*

4. Remove and discard old (control valve-to-cooler) hoses which are connected to power steering cooler (port and starboard).

5. Cut two hoses (from bulk hose supplied) of sufficient length to extend from power steering coolers to respective fittings on priority valve.

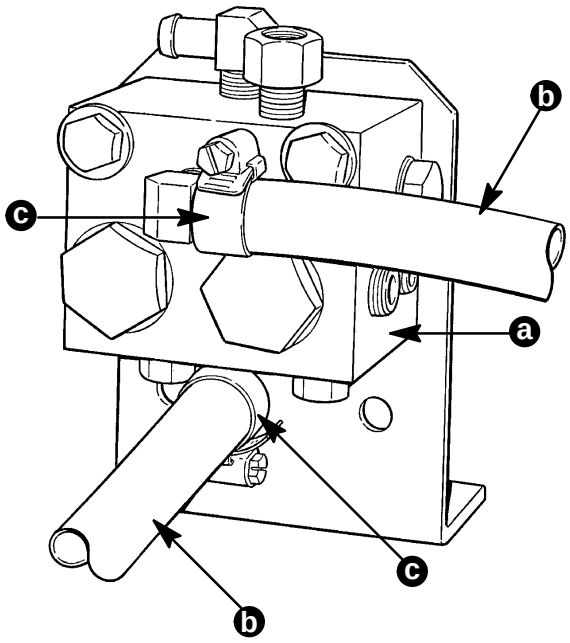
Index

6. Connect one end of each hose to its respective power steering fluid cooler and other ends to fittings on priority valve. Secure with hose clamps. Tighten securely.



73579

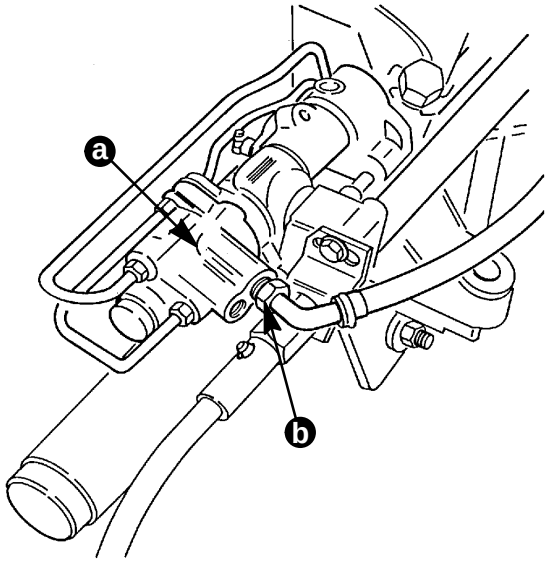
a - Power Steering Fluid Cooler
b - Hose
c - Hose Clamp



72862

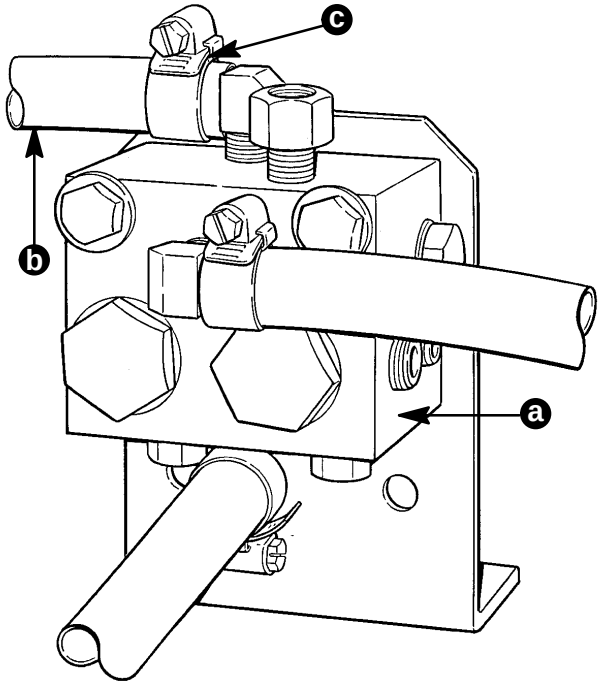
a - Priority Valve
b - Hose
c - Hose Clamp

7. Install return hose (large fitting on one end only, from kit) to power steering control valve. Route hose to priority valve, cut hose to length, and connect to fitting on priority valve. Secure with hose clamp. Tighten securely.



72863

a - Power Steering Control Valve
b - Hose Fitting

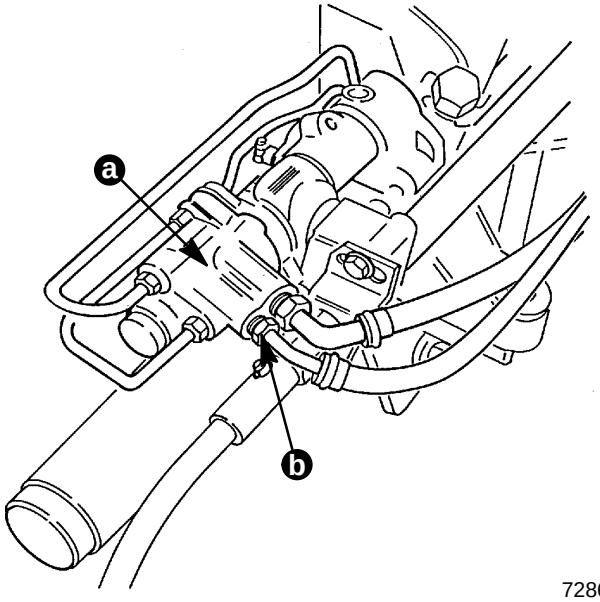


72864

a - Priority Valve
b - Hose
c - Hose Clamp

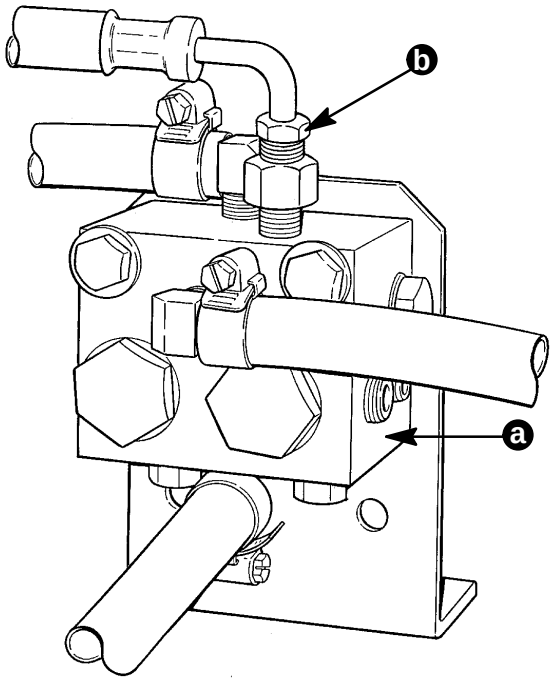
Index

8. Install pressure hose (fittings on both ends, from kit) between power steering control valve and large inverted flare fitting on priority valve. (This fitting location is marked with an “S.”) Secure with hose clamp. Tighten securely.



72865

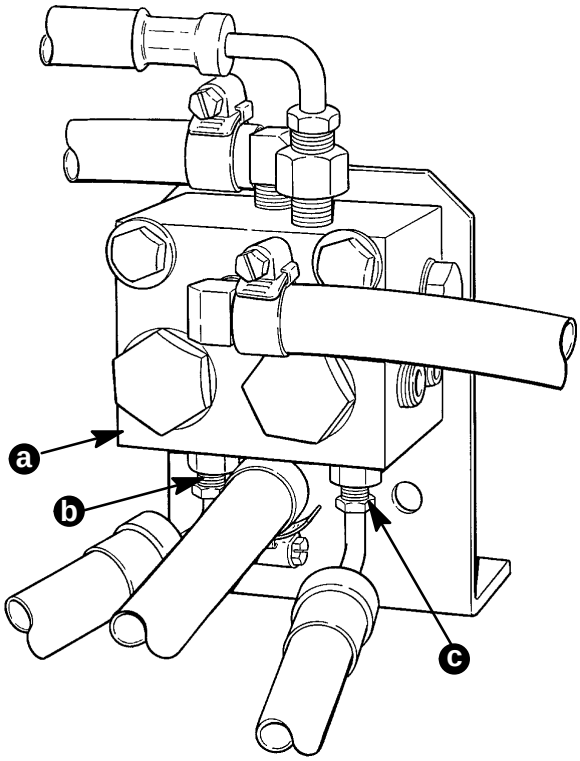
a - Power Steering Control Valve
b - Hose Fitting



72866

a - Priority Valve
b - Hose Fitting

9. Connect No. 1 (starboard) engine pressure hose (from pump) to inverted flare fitting marked by “1” on priority valve. Connect No. 2 (port) pressure hose (from pump) to inverted flare fitting marked by “2” on priority valve. Secure with hose clamps. Tighten securely.



72867

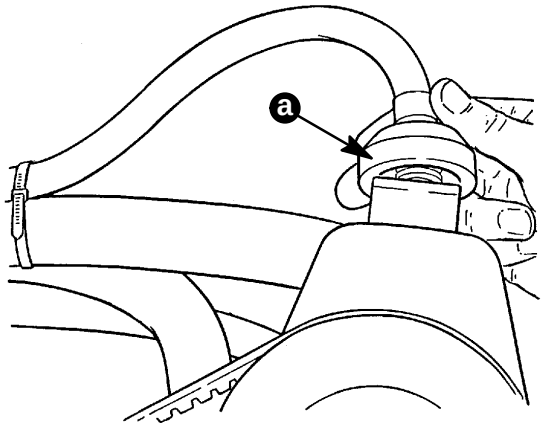
a - Priority Valve
b - No. 1 (Starboard) Pressure Hose
c - No. 2 (Port) Pressure Hose

10. Secure all hoses with Sta-Straps provided.

Index

Filling System with Fluid

11. Fill pump reservoirs with automatic transmission fluid (ATF) Dexron ll.
12. Install and tighten pump cap by turning cap clockwise approximately 120 degrees.



72868

a - Cap

13. Fill reservoir bottle to full mark, then (one at a time) slightly loosen pump cap to allow fluid to flow from reservoir to pump until pump just starts to overflow, then quickly tighten pump cap. Fill bottle reservoir and repeat this process for the other pump.
14. Double check both caps to ensure they are both tight.

Maintenance

Maintenance inspection is the owner's responsibility and must be performed at the following intervals:

Normal Service - Every 50 hrs. of operation or 60 days (whichever comes first)

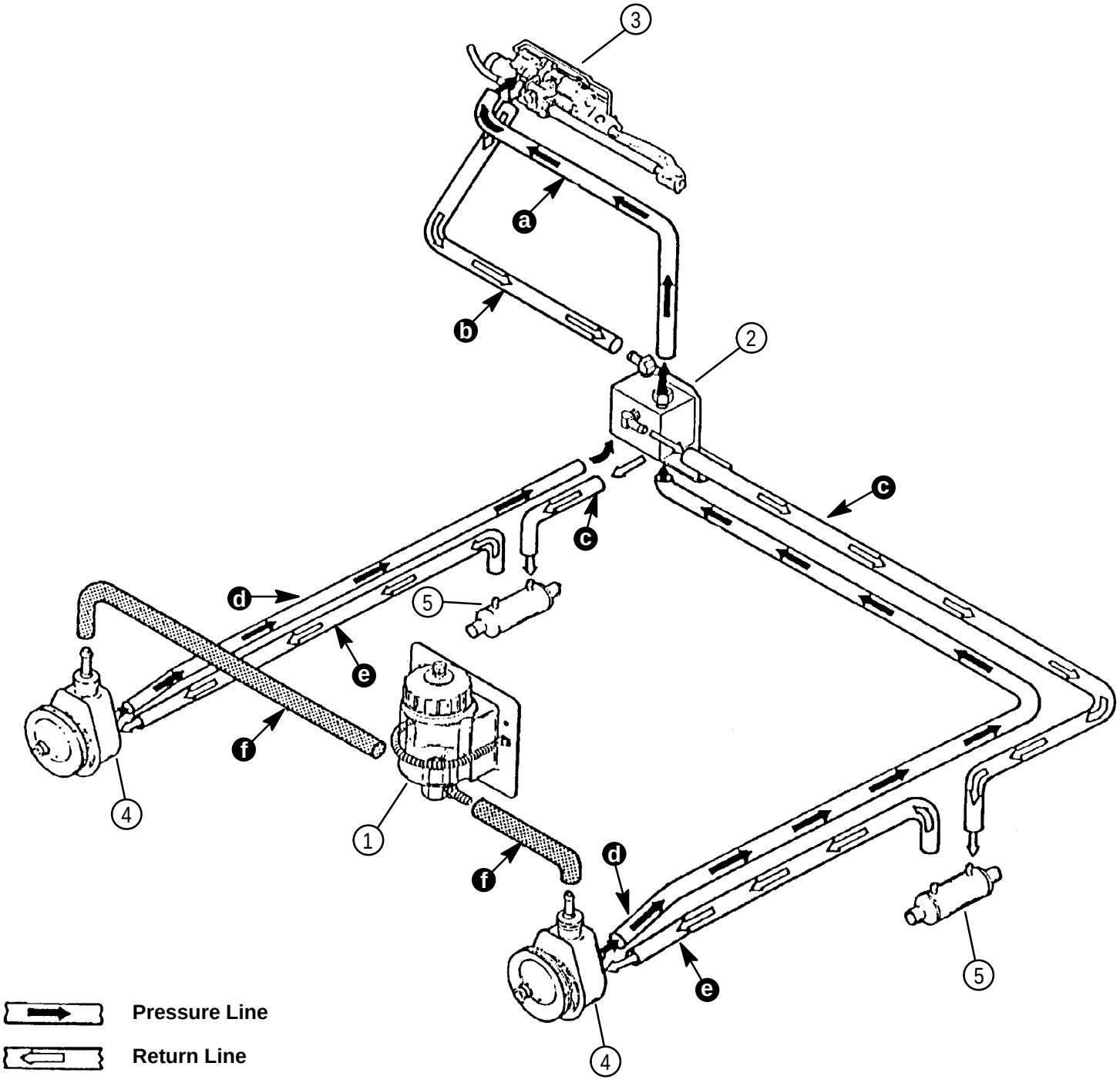
Severe Service - Every 25 hrs. of operation or 30 days (whichever comes first)

NOTE: *Operation in salt water is considered severe service.*

15. Check all connections and hose clamps for adequate tightness. Tighten, if loose.
16. Check all mounting bolts and tighten if necessary.
17. Be sure to check reservoir oil level periodically.

Index

System Flow Diagram



Pressure Line

Return Line

Gravity Feed Line

72995

1 - Reservoir Bottle and Bracket
2 - Priority Valve and Mounting Bracket
3 - Power Steering Control Valve
4 - Power Steering Pump
5 - Power Steering Fluid Cooler

a - Pressure Hose (Fitting on Both Ends - Supplied in Kit)
b - Return Hose (Fitting on One End - Supplied in Kit)
c - Return Hose from Pump (Cut from Bulk Hose Supplied)
d - Pressure Hose from Pump
e - Return Hose from Pump
f - Gravity Feed Hose (Cut from Bulk Hose Supplied)

Index